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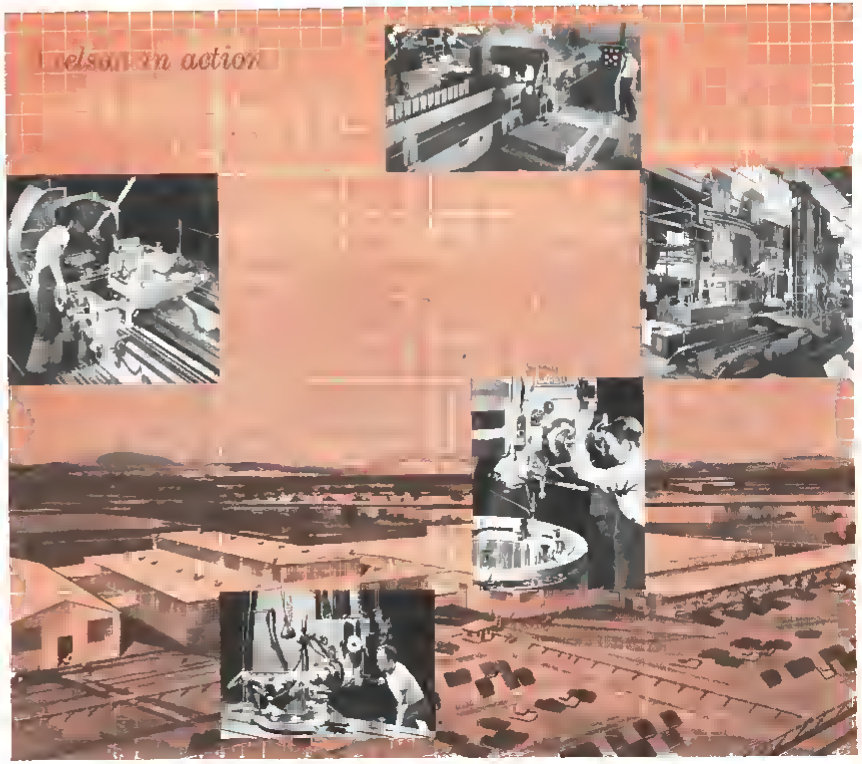

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AVIATION CALENDAR

Dec 5-7—Instrumentation Conference & Exhibit, sponsored by the Professional Group on Instrumentation and the Atlanta, Ga. Section Institute of Radio Engineers Biltmore Hotel Atlanta Ga
Dec 6-7—Third Annual Meeting American Astronautical Society, Hotel Edison, New York N Y
Dec. 7—Open House and Air Power Show Myrtle Beach AFB S C
Dec 7—Symposium on Ecology of Air Transport Institute of the Aeronautical Sciences 7660 Beverly Blvd Los Angeles, Calif
Dec 17—Annual Wright Day Dinner Sheraton Park Hotel Washington, D C
Dec. 28-31—Third King Orange International Model Plane Contest, U. S. Marine Corps Air Station Miami Fla
Jan 21-22, 1957—Symposium on Solar Furnace Design and Operation Hotel Westward Ho, Phoenix Ariz
Jan 27-28—American Society for Metals Albuquerque and Los Alamos Chapters "Heat Tolerant Metals for Aerodynamic Applications," Albuquerque N M
Jan 28-31—8th Plant Maintenance & Engineering Conference Public Auditorium Cleveland Ohio
Jan 31—Sixth Annual Instrument Short Course, Los Angeles Harbor Junior College, Wilmington Calif Additional course will be held Feb 1
Feb 7—Operations Research Symposium University Museum Lecture Hall University of Pennsylvania Philadelphia Pa
Feb 7—Annual Mid Winter Symposium of the New York Section, Instrument Society of America Garden City Hotel Long Island, N Y
Feb 14-15—1957 Transistor and Solid State Circuits Conference University of Pennsylvania Philadelphia, Pa
Mar 7-9—National Conference on Aviation Education Hotel Mayflower, Washington D C
Mar 11-15—1957 Atomic Exposition including Nuclear Engineering & Science Congress, 5th Atomic Energy in Industry Conference and 5th Hot Laboratories & Equipment Conference, Convention Hall Philadelphia Pa

AVIATION WEEK • DECEMBER 3 1956
Vol 65, No 23

Valve Talk

FOR WM. R. WHITTAKER CO., LTD.
BY MARVIN MILES

Too long had plating been an intermittent problem at Whittaker.

Although some processing was done within the plant, most of the work was handled by vendors. The bulk of it came up to standard, but there were always some jobs below quality or the processing itself was incorrect.

Delivery delays were inevitable and costly.

With practically all of its many valves and components requiring processing in some form or another, the company decided to end the problem some six months ago, investing a substantial amount in the design and construction of new plating shops while at the same time streamlining and progressively improving existing facilities.

Today, Whittaker's versatility in finishing operations has few equals throughout the country and its processes have been fully approved by the Air Force.

Plating procedures work in smooth, continuous flow and the work is done correctly and on schedule, eliminating time waste and headaches.

Only infrequently, in the press of expanding production, does Whittaker utilize outside plating firms and in such case the units are hand delivered, waited for, checked and returned to the plant immediately.

Plating gives surface hardness to aluminum areas through a thin but highly effective coating that enables them to resist abrasion and wear and it also preserves and protects them against the effects of oxidation, corrosion and electrolytic action. Graphite plating provides lubrication for moving parts that lasts for the lifetime of the valve.

Larger tanks and improved equipment — organized in step saving layout that permits greater production with no increase in personnel — form the basis of Whittaker's accelerated efficiency in the plating department.

There are two hard anodizing tanks powered with rectifiers and remote controls, three chromic acid anodizing tanks and the innovation of two large refrigerated sulphuric acid anodizing tanks.

The still or tank plating cycle consists of cadmium, copper, nickel and chrome, with the chrome tank to be used primarily for dense chrome plating.

In barrel plating, Whittaker has set up cadmium and silver plating and in addition to the plating processes the department's operations are supplemented with processes governing the blackening of steel, impregnation of castings, pressure testing of valve bodies and component parts, methods of forming protective chemical films for aluminum and aluminum alloys, belt sanding, pressure blasting, deburring and degreasing.

All of Whittaker's equipment is protectively treated with acid-resistant polyvinyl coatings, with the added protection of an elaborate blower system.

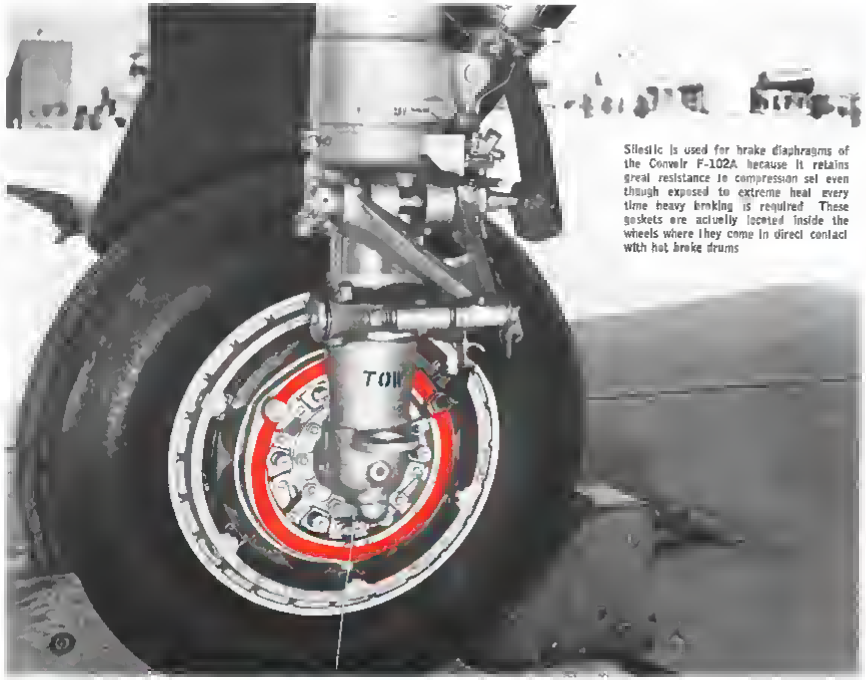
Another unique feature comprises the protective measures taken in setting up the department's panel board and generator room. All meters and controls are enclosed, with access only from the generator room thus eliminating any possibility of fume corrosion so predominant in the majority of plating rooms.

Also in full swing is the company's new Graflube department, a dry lubrication process that has been combined and coordinated with the spray painting department.

Here the Whittaker facilities consist of one large water wash spray booth and two heavy-duty high heat ovens, with facilities for racking, masking and compounding. This process not only helps expedite the production requirement, it gives much closer control on the quality of Whittaker processing.

Whittaker estimates the expanded and modernized department will save the company thousands of dollars annually, not only in eliminating the occasional problems met previously with outside vending sources but in stepping up its own production flow.

New versatility for the plating shop adds another notch in the company's over-all versatility, one of many innovations, modifications and improvements now underway or planned for the immediate future to keep Whittaker ahead in the aircraft valve field.



Silastic is used for brake diaphragms of the Convair F-102A because it retains great resistance to compression set even though exposed to extreme heat every time heavy braking is required. These gaskets are actually located inside the wheels where they come in direct contact with hot brake drums

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• Tear strength, lb/in	40 to 75
• Compression set, %, @ 300 F	20 to 40
• Hardness range, durometer	20 to 80

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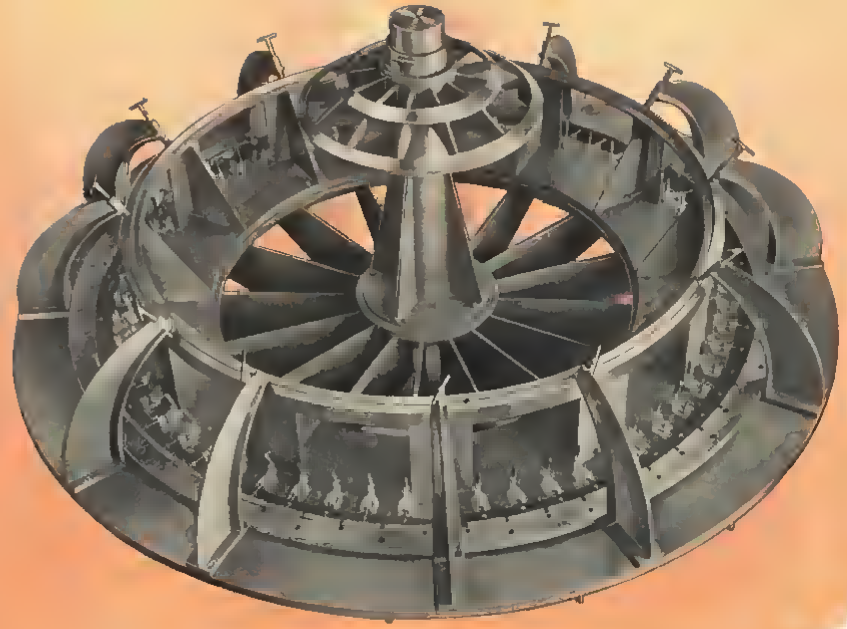

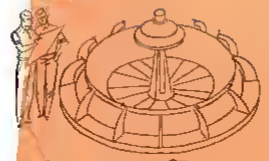

MISSILES and MEN

The photograph shows a mammoth tool made by Hayes for use in the production of guided missiles by the Army Ballistics Missile Agency at the $57 million Redstone Arsenal, Huntsville, Alabama. The tool is about 9 feet in diameter, with a specified tolerance of .003 of an inch.

Modern automation and the use of atomic energy are so dramatic that an equally important factor in the field of guided missiles is sometimes overlooked. It is the human element — the skill of the men who make the machine. After all, technological progress either in aircraft or guided missiles is not a nuclear or mechanical product. It is a product of the minds of men.

Hayes is proud to play a part in the production of the spectacular Redstone missiles. We are even more proud of the Hayes engineers, tool design personnel, technicians, tool and die makers and jig builders whose skill made possible this new phase of Hayes activity.

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Wright cranes keep engines flying through world's largest line-maintenance hangar

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24 motor driven Wright cranes like the one shown keep engines winging from station to station in the world's largest line-maintenance hangar at Miami. And keeping the cranes on the go are 384 Timken® tapered roller bearings on the bridge wheels and trolley wheels.

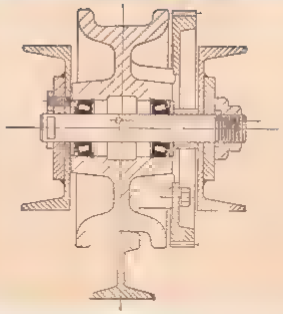
Timken bearings take both the radial loads imposed by the weight of the engines and the thrust loads set up by the pendulum motion of crane operation. The tapered design of Timken bearings lets them take radial and thrust loads in any combination. And full line contact between rollers and races gives these bearings extra load-carrying capacity. Downtime is cut, cranes are kept on the go.

Friction is virtually eliminated with Timken bearings. They're designed by geometric law to have true rolling motion—precision manufactured to live up to their design. Cranes roll smoothly with a minimum of wear and maintenance. And to take the shock loads often encountered, rollers and races of Timken bearings are case-carburized to give them wear-resistant surfaces over tough, shock-resistant cores.

Be sure you specify Timken bearings when you build or buy a machine. To give you the *finest* roller bearings, we even make our own fine alloy steel. We're America's only bearing manufacturer that does.

Look for the trade mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO"

This symbol on a product means its bearings are the best



How the **WRIGHT HOIST DIVISION** of American Chain and Cable Co. mounts Timken tapered roller bearings on the trolley wheels of its cranes to take the loads, keep them on the go.

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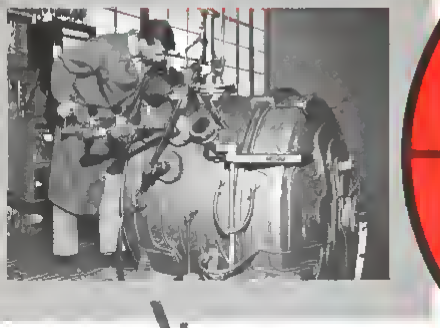

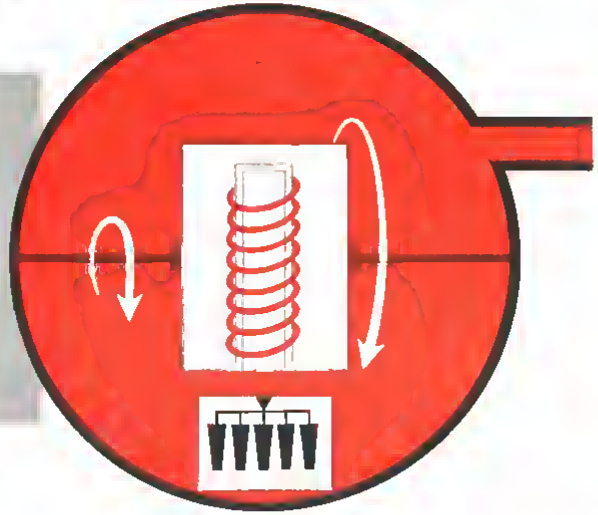

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For instance, these new Austenal techniques are already being studied for aircraft manufacturers on a development basis Vacuum melting has helped furnish extremely high quality vanes and blades for future jet engines.

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DECEMBER 3, 1956

AVIATION WEEK

VOL. 65 NO. 23

Editorial Offices New York 36—330 W. 42nd St., Phone LOngacre 4-3000 (Night LO 4-3035)
Washington 4, D. C.—National Press Bldg., Phones NAtional 8-3414, REpublic 7-6630
Los Angeles 17—1125 West Sixth St., Phone: MAdison 6-9351

COVER- Lockheed C-130A Hercules turboprop combat transport for USAF, is in quantity production in Government Aircraft Plant No. 6 Marietta, Ga. First deliveries of the Hercules are scheduled for this week. The planes will be assigned to Tactical Air Command. C-130A, built around four basic missions, can carry payloads approaching 40,000 lb. into unprepared fields at airheads in combat zones. Interior can be quickly converted to airlift wounded out of the airhead or to carry a variety of air-dropped loads. An engineering analysis of the C-130A begins on page 50.

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33—UP Photo

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AVIATION WEEK • DECEMBER 3, 1956 • Vol. 65, No. 23
Member ABP and ABC

Nuclear Sabre Rattling

The battle over Suez has treated the world to a shuddering experience with the old-fashioned diplomatic technique of sabre-rattling in its modern technological trappings of intercontinental nuclear warfare. The first rattling of atomic bombs to produce diplomatic pressure in the Suez crisis came from Russia.

In a note to Britain and France, who were then attacking Egypt from the air, Soviet Premier Bulganin made a reference to the possible use of atomic or hydrogen-tipped, long-range ballistic missiles against aggressors. This was almost universally interpreted as a threat to rain these rocket-powered hypersonic missiles on western Europe and the British Isles from Russian territory unless the attack on Egypt stopped.

Red Missile Tests

It is not yet generally realized in this country what a shock this thinly veiled threat produced in the chancelleries of western Europe. For it has been known beyond all shadow of doubt in official western military circles for some time that the Russians have the capability to carry out that threat at any time.

First development test firings of a Russian intermediate-range ballistic missile over ranges of 900 to 1,000 miles were detected by reliable scientific apparatus more than 18 months ago on test ranges in the Ukraine and in the Soviet Arctic. The fact that these firings were well known in the Pentagon was reported by AVIATION WEEK last Feb. 20 (p. 26). These firings have increased during the past year to a current rate of about five per month. This rate plus other information indicates that the Russians have been in production of this 1,000-mile ballistic missile for some months and have delivered it for operational use to field units.

This information is well known to the top level governmental circles of the NATO alliance. None of the NATO governments have seen fit to inform their people, who would be slaughtered in a rain of atomic tipped rockets, of these facts. But it is this knowledge of what capability the Russians have actually developed in ballistic missile warfare over a 1,000-mile range that caused the most profound shock in Britain and France and put the real brake on their Suez adventure. Russia's later preparations to send air force, tank and artillery "volunteers" to Egypt only added to the scare created by Bulganin's threat of missile attack.

B-52 Counterthreat

It was to take some of the chill off this threat that the United States staged its record-breaking flight of eight Boeing B-52 Stratofortress bombers demonstrating nonstop flight capabilities of 17,000 miles with extreme flexibility of route to and from targets (see p. 31). This demonstration by the crews of the 42nd Heavy Bomb Wing based at Loring AFB in Maine and the 93rd Heavy Bomb Wing at Castle AFB in California offers convincing evidence of the speed and certainty with which Strategic Air Command is developing its most modern long-range striking force. The eight B-52s on this exercise could have dumped a devastating load of hydrogen destruction on any portion of the Soviet Union. This is the lesson that the United States wanted to demonstrate for all the world—friends, foes and neutrals—to see.

The flight of the eight B-52s made it clear to the Russians that no matter what kind of missile rain they could loose on western Europe, Britain and North Africa, their own territory could be subjected only hours later to the hydrogen bomb loads of SAC's B-52 fleet operating from bases far beyond the range of Russia's current missile capability.

Thus, the Russians have made their threat, and the United States has demonstrated its counter-threat. The world will have to judge how this balance of nuclear airpower hangs at this particular moment.

Future Airpower Balance

Of even more importance is how the balance of nuclear airpower will hang in the future. The fierce pace of technological weapons development assures the obsolescence of any new weapon system before it gets onto the production line and into operational service. The intercontinental range of refueled B-52s may checkmate the Russian intermediate-range ballistic missile at the moment. But what will the international chessboard look like when the Russians produce a genuine intercontinental ballistic missile capability that can reach the SAC bases that are now out of range? Will the United States produce this capability first? If so can it be used with the same effectiveness to counter Soviet policy? These are questions that only the future can answer.

The only thing we know for certain now is that it is utter folly to be deceived by any Soviet policy shifts aimed at slowing our weapons development pace or reducing the effective growth of our nuclear airpower strength. We only have to recall the rosy aura of phoney "peace" generated by the Geneva conference a scant 20 months ago in the light of the Hungarian blood bath, the battle over Suez and the Polish revolt to see how fast and deadly Kremlin policy shifts can be for the unwary and unprepared.

We earnestly hope that the military policy and budget debate for Fiscal 1958 will be conducted with genuine realization of the defense needs of this country and its allies for survival rather than as a routine bureaucratic budget exercise whose only goal is a tidy fiscal accounting.

—Robert Hotz

WHO'S WHERE

In the Front Office

D. N. Taylor, a director and secretary-treasurer, Pastushin Aviation Corp., Los Angeles, Calif.

Robert B. Manning, president, Sperry Western, Inc., a subsidiary Sperry Products Inc., Danbury, Conn. Also, Clinton R. Hilliker, operating manager and a director.

Dr. Raymond L. Garman, executive vice president-technical director, and James W. Murray, executive vice president-general manager, General Precision Laboratory, Inc., Pleasantville, N. Y. Also, Richard W. Lee and William J. Tull, vice presidents.

Blevins R. Fondren, executive vice president and a director, Menasco Manufacturing Co., Burbank, Calif. Also, Thomas J. Tormey, secretary, Frank G. Fenger, vice president-manufacturing, Jack L. Hamilton, vice president-sales, Glenn E. Vescelius, vice president-engineering.

KLM Royal Dutch Airlines has appointed the following senior vice presidents: J. A. Bach, operations; V. H. L. Doubourcq, field organization; T. M. van Erp, planning; A. H. van Gelder, finance; J. C. van der Kloot, marketing; and J. Luymes, engineering and maintenance.

Dr. Donald D. King, vice president-research, Electronic Communications, Inc., and director of Electronic Communications new Research Laboratory, Baltimore, Md.

Arthur V. Loughren, vice president-Research Division, Airborne Instruments Laboratory, Mineola, N. Y.

John N. Kerr, vice president, Horkey Associates, Los Angeles, Calif.

Honors and Elections

Dr. A. E. Lombard, Jr., Director of Research for McDonnell Aircraft Corp., has received the Air Force Decoration for Exceptional Civilian Service. A citation signed by Air Force Secretary Donald A. Quarles praised Dr. Lombard's "exceptional civilian service and performance of duty" during the 7-year period he served as Scientific Advisor to the Air Force.

John T. Henderson, principal research officer of the National Research Council, Ottawa, Canada, has been elected president of the Institute of Radio Engineers for 1957. Dr. Henderson succeeds Arthur V. Loughren.

Capt. J. H. Foy, a pilot with Trans-Canada Air Lines, has been elected president of the Canadian Air Line Pilots Association for a two-year term.

The 4926th Test Squadron (Sampling) of the 4950th Test Group (Nuclear) at the Air Force Special Weapons Center, Albuquerque, N. M., received the Air Force Outstanding Unit Award from Lt. Gen. Thomas S. Power, head of Air Research and Development Command. The Award is presented to units which have distinguished themselves by exceptionally meritorious achievement or meritorious service in support of military operations, or service of great national or international significance not involving combat operations against an enemy.

(Continued on p. 93)

INDUSTRY OBSERVER

► Convair is proposing a new development of the F-102 all-weather fighter series with a top speed of well over Mach 2. Tentatively designated the F-106C, the development will feature a clipped vertical fin and canard design. It will be powered by an advanced development of the Pratt & Whitney J75 turbojet engine. The F-106A will be the first J75-powered version of the basic F-102 design, with a Mach 2 performance and extreme high altitude capability. The F-106B is a tandem seat version of the A model to be used both for training and tactical missions.

► First programmed Vanguard test firing is scheduled for this week at the Air Force Missile Test Center, Cocoa, Fla. Test vehicle is a standard Martin-built Viking rocket—the 13th in the series—powered by a Reaction Motors' liquid-propellant rocket engine developed for the Viking series. Basic purpose of the test is for crew familiarization with the launching and handling of a large rocket vehicle. However, the nose cone will be separated and some re-entry temperatures measured.

► Chance Vought Aircraft will introduce a reconnaissance version of its F8U Navy fighter within the near future. Cameras probably will be housed in fuselage rather than in the nose. Chance Vought engineers feel necessary lengthening of the nose to house the cameras would cost too much in performance.

► Army's Loki anti-aircraft missile project based upon the German Taifun of World War II has been terminated. Early success with the Raytheon Hawk indicated that the final version of the Hawk would be available not too long after the interim Loki weapon was ready. Small time lost between the effective dates of the two weapons was believed worth accepting in view of the greater value of the Hawk as a weapon. Bendix was prime contractor for the Loki. Northrop manufactures the Hawk as subcontractor to Raytheon.

► Boeing B-52's steerable forward landing gear is controlled by pushing the aircraft's rudder pedals. The steerable wheels on transports and the earlier type bombers usually are operated by means of a lever or small steering wheel.

► Fuel for Vanguard's first-stage General Electric power plant is now RP-1, a standardized kerosene with physical characteristics narrowed and controlled to make it suitable for liquid rocket use. Runs with wide-cut gasoline proved so inconsistent that General Electric switched to JP-4. However its characteristics also varied so that performance could not be consistently duplicated. The switch to RP-1, which is manufactured by Shell Oil Co., followed.

► Costruzioni Aeronautiche Giovanni Agusta, Italian aviation firm located near Milan, is constructing a helicopter of original design to carry 14-16 passengers. The firm, which has been building Bell 47G helicopters under license since 1954, recently signed a contract with the French government to manufacture 52 47G-2s.

► B-52 ejection system provides for the jettisoning of the entire tail cone aft of the tail gunner's seat. Ejected cone includes radar and armament. B-52 pilot and co-pilot eject upward, two observers eject downward. Other crewmen must find their way out through one of the holes.

► Ouest Aviation is sending three Alouette II helicopters to Boufarik, Algeria, for extensive testing. The aircraft, first French-made helicopters to appear in Algeria, also probably will be used on occasional combat missions against the rebels.

► Rocketdyne Division of North American Aviation has dropped out as a second source for engine to power Martin's Titan intercontinental ballistic missile. The apparent reason is success of first source engine project at Aerojet.

Washington Roundup

Army Second Thoughts

Top Army Aviation officers are saying privately that Army's eagerness to play a leading role in the ballistic missile field is to blame for weight and mission limits imposed upon Army aircraft in Defense Secretary Charles E. Wilson's memorandum of clarification issued last week on roles and missions (see page 30).

The Air Force, these officers say, was determined to push the Army out of the long range missile field and, in its fight to accomplish this at the Joint Chiefs of Staff level, condemned all of Army's aviation activities in the same stroke, insisting upon sharp restrictions on both aircraft weight and missions.

Actually, these officers say, a limited, but much needed increase in aircraft weight and some expansion in allowable missions could have been allowed the Army without any infringement upon USAF prerogatives. If they add, Army planners had restricted their efforts to the aircraft field without straying into—and placing emphasis upon—long range missiles, some of Wilson's restrictions might have been averted.

Gruenther Defense Candidate?

Meanwhile, the newest name being mentioned as a possible successor to Defense Secretary Wilson when and if he retires, is Army Gen. Alfred Gruenther, recently retired chief of NATO's military forces. Supporters of this viewpoint say Gruenther's appointment as head of the American Red Cross is a step toward "civilianization" of a military man and one of the legal moves necessary to make him eligible for the Defense post. Other names still prominent in the Pentagon whispering race are Air Force Secretary Donald A. Quarles and Army Secretary Wilber Brucker. Another new entry is the name of Henry Cabot Lodge, U.N. Ambassador.

Great Circle Route Circle

The Civil Aeronautics Board is right back where it started last January in the handling of the renewed struggle between Pan American World Airways and Northwest Airlines over the Great Circle Route to the Orient. After handling Pan American's bid for the Great Circle Route and Northwest's bid for permanency on the route separately for nine months, the Board has reverted to its original plan and will decide the two issues together.

Northwest's application for permanency has received the approval of the examiner and was set for submission of briefs and oral argument. Now this schedule has been canceled, and the Board has ordered concurrent briefs and a single oral argument for both cases. The Pan American case is still awaiting an examiner's report.

When President Eisenhower asked the CAB last January to bring the record up to date on Pan American's Great Circle application, the Board decided to include the issue of permanency for Northwest's Great Circle Route. A decision on Pan American's application was deferred by the White House a year earlier, and at the same time Northwest's request for permanency was refused. When it reopened the Pan American case, the Board wanted to include the Northwest issue.

The White House upset this plan in March when it instructed the Board to confine its record to the issue of Pan American's application. So the case was split, and Northwest's application has been handled separately. When the examiner reported on the Northwest case, he suggested that the two cases be considered together because of the possible effect on U.S. foreign aviation policy in the Pacific and decision in the Northwest case might have. Now the Board is holding the Northwest case until the Pan American case catches up, then it will consider them together.

Small Firms and Defense Dollars

With more and more of the defense dollar going for aircraft and missiles, the Defense Department is finding it increasingly difficult to place prime contracts with small businesses. In a speech before a conference of small businessmen last week, Assistant Secretary of Defense for Legislative and Public Affairs Robert Tripp Ross explained why:

"In the Defense Department we have a confidential list of important weapons which we call the Preferential Planning Lists.

"Under the heading of 'aircraft' the Air Force has 73 items, all costing more than $10,000 each. There is not a single known small business supplier for any of these items.

"Under the heading of 'guided missiles,' there are nine items with a unit cost over $10,000 each. There are no known small business sources for any of them.

"The Navy lists 54 items under aircraft and 14 items under guided missiles, and, here again, there are no known small business sources for any of them.

"The Army also lists guided missiles for which there is no known small business source.

"For the small and more conventional items, this is not the case. In every category such as 'vehicles' or 'ammunition,' there are many items obtainable from small firms. The Navy's ships include 28 items obtainable from small firms."

More Airways Support

Edmund Curtis, presidential assistant for aviation facilities planning, last week called for continued financial support by Congress of the Civil Aeronautics Administration's three-year federal airways plan. Speaking before the Washington Aero Club, Curtis pledged his support of the present CAA program and urged that it be pushed forward with "vigor and enthusiasm." He said current problems of air traffic control must be faced now and in the months ahead before major improvements in the system can be implemented. "The best we can hope to do in the near future," he said, "is to bolster the present system and get the most we can out of it."

Wings for Army Brass

Anticipating a pinch of general officers for its aviation program, the Army has ordered a third candidate to start flight training at Ft. Rucker, Ala., in February. He is Brig. Gen. Bogardus S. Cairns, now serving as Deputy C-3 (Operations) of the Continental Army Command, Ft. Monroe, Va. No berth in Army Aviation has been named as Gen. Cairns' future assignment, but his selection to learn to fly probably means other officers of his rank will be sent to the Army Aviation School during the year.

—Washington staff

New Rocket Research Vehicles Detailed

American Rocket Society receives data on upper atmosphere research programs at annual meeting.

New York—More than a dozen rocket-powered vehicles in current use or proposed for upper atmosphere research programs were described in detail to the annual meeting of the American Rocket Society here last week.

With the first scheduled firings for the International Geophysical Year already taking place several months ahead of the formal beginning of the study period, there has been renewed interest in the data to be obtained from the belt between 20 and 200 miles above the surface of the earth. Right now the skies over New Mexico are the most thoroughly explored in the world because of the White Sands Proving Ground and Holloman Air Development Center firing sites with their complex of fixed launchers.

Solid propellant rockets offer the only hope of extending geographic coverage of the rocket sounding program, said Homer E. Newell, Jr. of the Naval Research Laboratory.

The outstanding reason is the operational simplicity of the solid fuel rocket which can be set up and fired at remote locations with minimum cost and logistic support.

The Deacon and Cajun rockets using Nike boosters are the only truly inexpensive vehicles available to the upper air researcher, Newell said. They cost only a few thousand dollars per round compared to the $30,000 $40,000 cost of the Aerobee rocket.

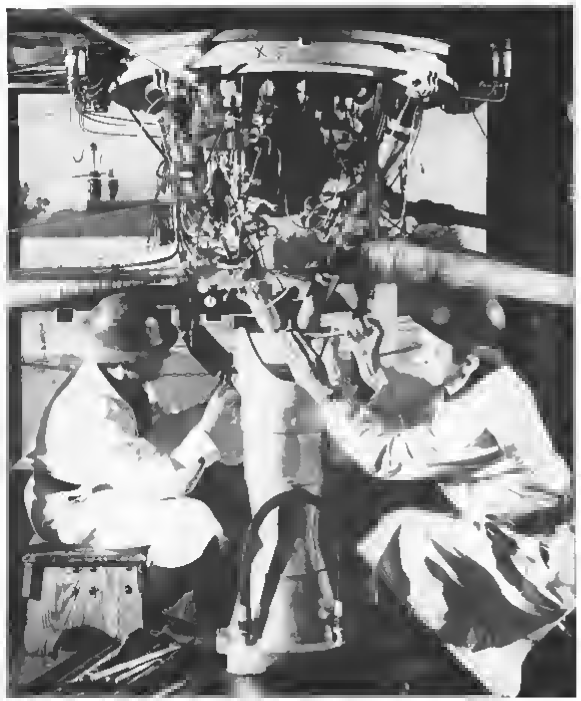
The Iris rocket, solid-propellant counterpart of the Aerobee now under development, should be considerably less expensive than Aerobee, Newell added.

Suggestions made by Newell for design improvement of sounding rockets included:

- **Building the rocket control system into the experimental equipment only** to reduce the payload penalty of building control into all vehicles of a series.
- **Reduce contamination** of the atmosphere around the rocket by sealing the instruments, tanks and the motor itself after burnout, and avoiding gassy coatings on the surface even to the extent of leaving the rocket unpainted.

Aerobee Hi sounding rockets probably will incorporate an Aerojet-General 5,000 lb. thrust ceramic lined motor replacing the regeneratively cooled unit now standard on the vehicles developed by Aerojet for both Air Force and Navy. John W. Townsend, Jr. of the Naval Research Laboratory and Robert M. Slavin of the Air Force Cambridge Research Center said in a joint paper that developed versions of the Aerobee-Hi are expected to carry 150 lb. payloads as high as 170 mi. during the experimental firing program of the International Geophysical Year.

Two models of the sounding rocket will be available for both services and will be fired by them. The Navy requirement called for higher altitude capability, tank capacity of the Navy Aerobee Hi has been increased and the rocket is about 30 in. longer than the Air Force model.



GENERAL ELECTRIC X-405 rocket engine for Project Vanguard will deliver a thrust of more than 27,000 lb. when it launches the 11-ton, three-stage Vanguard rocket during the International Geophysical Year. X-405 will run for about 150 sec. At burnout, the X-405 will have accelerated Vanguard rocket to 4,000 mph.

Nike-Cajun Vehicle

Forty-two Nike-Cajun sounding rockets will be fired at the Fort Churchill site during the International Geophysical Year, according to Leslie M. Jones and Warren W. Berning of the University of Michigan. A fully equipped launching site has been constructed for the rounds. In addition, 23 more rounds of the vehicle will be fired from shipboard, at White Sands Proving Ground, and at Guam.

The Nike-Cajun rocket costs in its present form about $4,000, exclusive of instruments and booster. The booster costs $3,700 if purchased, instead of being received as a donation from the Army. Actually, the complete round can't be purchased as a unit but must be assembled by the user from separate items from several locations.

NACA's Pilotless Aircraft Research Division was credited by the authors with specifying Cajun and for working out the Nike-Deacon combination that led directly to the later vehicle combination.

A family of high-altitude sounding rockets based on the Aerobee but with peak altitudes up to 400 mi. was proposed by Aerojet engineers.

The basic Aerobee rocket has a limiting summit altitude on the order of 250 mi. Built around a four-motor configuration and carrying a 100-lb. payload, an advanced Aerobee should have an altitude capability in excess of 300 mi., says Aerojet. The advanced rocket would be 18 in. in diameter and 312 in. long.

The Spaciobee is another adaptation of the standard Aerobee rocket. It would carry as its payload a second stage powered by an Aerojet 1.8 KS 7800 solid propellant rocket. Payload of the second stage could be varied between 20 and 60 lb. Peak altitudes would approach 400 mi.

Third proposal made by Aerojet is the Rockaire system in which a solid propellant rocket is fired from an airplane that has zoomed into a vertical attitude. Douglas Aircraft Co. has a Rockaire system under development using the 1.8 KS 7800 rocket. By launching at 35,000 ft. and Mach 0.8, a 40-lb. payload could be carried 45 miles high. If a 20-lb. payload were used, the altitude increases to 54 mi.

A solid propellant rocket system visualized by the Aerojet engineers could be capable of delivering a 6¼-in. diameter 250 lb. payload to a 90 mi. peak. If the payload were replaced by an ASP rocket, a 50-lb. payload could be carried to 490 mi.

The solid fuel unit is a three-stage system with roll stabilization and jet-vane controls to permit zero-length launching.

ASP Performance

A perfect reliability record of over 80 firings has been established by the ASP rocket designed and built by Cooper Development Corp. Charles M. Zimney of Cooper said that ASP could be used tactically as a high performance air-to-air or ground-to-air missile with the addition of a guidance system.

The ASP payload is variable between 25 and 50 lb.

Two-staged with a Nike Booster the ASP has a calculated capability of 850,000 ft. with a 25-lb. payload. As a single-stage vehicle, it can go to 200,000 ft. with 25 lb. or 170,000 ft. with 50 lb. starting from sea level.

The Air Force's Rockaire program, now in its first phase with launchings at Holloman Air Development Center checking the theoretical calculations, was described by Robert M. Slavin of the Air Force Cambridge Research Center.

Second phase of the work will be the launching of completely instrumented rockets from an F-86D using ground tracking and telemetering.

For the third phase, a Convair C-131B will accompany the fighter launcher to collect the flight data. The C-131B will be an airborne telemetering station. Expected capability: 100-mi. altitudes to be reached by ultimate development of the program.

Britain's Skylark research rocket developed for a joint research project by the Royal Aircraft Establishment and a number of universities was described by E. B. Dorling of RAE.

A single-stage, solid propellant rocket, the Skylark is 25 ft. long and 17½ in. in diameter. Powerplant is a Raven motor which has a thrust of 11,500 lb. The vehicle is fin-stabilized.

Expected altitude is 490,000 ft. with a 65-lb. payload. The addition of a booster should push the altitude to 700,000 ft.

The first launcher has been built at the Woomera testing range in Australia and the first firings are expected to begin later this year.

Simulated Human

A computer which appears to be able to simulate the non-linear response of human operators in complex control systems, based on limited tests to date, was reported by Dr. Anthony Cacioppo. Cacioppo is head of human factors in Goodyear Aircraft Corp.'s Aerophysics Dept.

If subsequent tests confirm that computer simulation of human response is indeed possible, it will open the way to better understanding of human control reactions and their quantitative measurement and analysis, Cacioppo indicated.

Several different basic approaches to the design of inertial guidance accelerometers, integrators and integrating accelerometers were described in a paper by J. M. Slater of North American's Autonetics Division. The paper was delivered by Slater's associate, Doyle E. Wilcox.

In describing the extremely severe accuracy requirements imposed by inertial navigation systems (errors of no more than one part in 10,000) Wilcox concluded that no single design approach is suitable for all systems.

The annual meetings of the American Rocket Society and the American Society of Mechanical Engineers were covered by an Aviation Week editorial team of David A. Anderton, George L. Christian, Robert H. Cushman, Glenn Garrison, Russell Hawkes and Philip J. Klass.

Program Aimed at Manned Space Flight Started by USAF Group

By David A. Anderton

New York—First steps of a program aimed at accomplishing manned space flight are now being taken as a result of research initiated by the Directorate of Advanced Studies, Air Force Office of Scientific Research.

Work is about to begin on a rocket-powered unmanned test vehicle for flight at extreme altitudes much higher than the orbits of any planned satellites. The vehicle was developed in preliminary design by the Directorate, detailed design and fabrication of the rocket and its supporting equipment will be the responsibility of Aeroneutronics, Inc., a subsidiary of Ford Motor Company.

Competing Designs

Paralleling this is work to be done in a space-environmental chamber built by Litton Industries for the Directorate. This chamber is big enough for space suited technicians to move around and work in a synthetic environment simulating a spaceship.

The contract for the high-altitude vehicle was let on a competitive basis. Aeroneutronics was not the sole bidder.

The problem was somewhat simpler than that of developing an ICBM of comparable aerodynamic performance because the re-entry problem did not have to be solved for the test vehicle. The major purpose of the test program is to get some fundamental data at extreme altitudes and to transmit that data back to the earth. When the vehicle does re-enter the atmosphere, it will burn up from the sudden heat input of skin friction.

A second simplifying feature was the small payload chosen for the experiments.

Continued refinement of experimental techniques has reduced the payload of sounding rockets from the 2,000 lb. level of the V-2 to the 25 lb. of the smaller solid propellant research rockets used widely today.

There is no major breakthrough in the design or development of the rocket vehicle, instead, there is what Dr. Morton Alperin, head of the Directorate, calls a "... combination of ideas to overcome the tough problems."

Free radicals of chemicals are being investigated for rocket propulsion in

contracts sponsored by Alperin's office. Research along the lines originally suggested by Dr. Fritz Zwicky, now a consultant to Aerojet-General Corp., is being continued by Aerojet and the Phillips Petroleum Corp.

Work has been under way for about four years, aimed specifically at the use of free radicals in propulsion. Other work has been done on free radicals but in non-propulsive applications. Since the Directorate started its work, a large program has been instituted at the National Bureau of Standards by Department of Defense with the Army as the monitoring agency.

The studies still are in a fundamental stage trying to recognize and then stabilize the free radicals. Depending on the concentration of the free radicals in a propellant the specific impulse can vary from values around 600 sec. to as high as 3,000 or 4,000 sec. Current values of specific impulse for chemical fuels are around 250–350 seconds to be a limiting value for chemical fuels.

An example of the free radical is the case of a small amount of atomic hydrogen present in liquefied hydrogen. The free radicals combine and in combining release enormous energy.

Alperin said that if the propulsion studies of free radicals worked out as well as hoped, it should be possible to phase them into the rocket vehicle work to produce a big jump in performance. But he emphasized that speculation of performance improvement would be premature now.

Army Sponsors 8 Crane Studies

New York—Eight parametric studies for flying crane helicopters are being sponsored by the Army, said Meade H. Mitchell, Jr., chief of the Aeronautical Research Branch of Army's Transportation Research & Development Command.

Companies known to have study contracts include Bell, Fletcher, Hiller, Hughes, Kaman and Prisecla.

Studies are being made within frameworks limits of eight, 12 and 16-ton payloads and range requirements of 10, 25, 50 and 100 nautical miles. The range problem defines the fuel needed for takeoff, flight to destination, cargo discharge while hovering and return to base with 10% fuel left.

Mitchell told the American Society of Mechanical Engineers that the eight studies should be completed by next March.

The Army has set down certain design parameters for its flying cranes.

Diameter of the rotors will vary greatly from the very small ones used in ducted fan applications to 85 and 150 ft. diameters in the heavier eight categories.

Speed of 60 kt. will meet army needs. This speed will allow the copter to make headway against 40 kt. winds, yet is slow enough to eliminate any need for complex and weighty streamlining. Also cost will be reduced and design construction speeded.

The cockpit should be so designed to give the pilot an unobstructed view downward of the cargo and the landing or discharge spot.

The crew will probably consist of the pilot and a combination co-pilot/crane operator.

The copter should be so built that it does not require special ground handling equipment. As Mitchell put it, "we don't want land cranes to have to handle flying cranes!"

The machines should be easy to disassemble for air, ground or water transportation.

The flying cranes should have a ferrying range capability of 3,000 nautical miles with in-flight refueling.

Multiple powerplants are a must for reliability and to keep unit weight down. The engine should have a 1,000 hour overhaul life.

To save weight consideration should be given to making the landing gear strong enough to support only the helicopter and not its payload which could be loaded while the machine hovers.

Hovering time will range from 5 to 30 min. per mission.

Hovering design considerations should not take ground effect into account since the Army may require its copters to hover low over trees where such an effect is not felt.

Greater increased use of helicopters for amphibious landing was forecast within 10 years by Marine Col. Keith B. McCutcheon. The concept of "vertical envelopment" will have to be developed, according to McCutcheon to replace landings from massed ships vulnerable to nuclear weapons.

In the future landings will have to be made from assault helicopters operating from small carriers.

The Marine Corps, which as the last (1946) service to get into helicopter aviation is working to develop this new attack technique and already has several CVE carriers.

Helicopter landing operations would prove advantageous because the copters could be launched from ships underway in a dispersed formation. Because copters are 10 times as fast as World War II landing ships they can operate from carriers 10 times as far from shore. In addition tide and wind direction will become negligible factors.

To mount such an operation, the Marines will need a "whole family" of helicopters: one-man copters for courier service, four to four place copters for liaison and evacuation of wounded, assault troop copters carrying 12-14 men, and three and five ton cargo copters.

Marine helicopters will have to meet the requirements of ship compatibility. This means automatic folding blades (which is technically possible but at a 20% increase in rotor weight), ability to taxi, and a geometry that will fit on elevators and hangar decks. Also, the copters must be easily repairable under front line conditions and must be capable of carrying out their missions in IFR weather.

The use of helicopters as flying cranes to move a complete oil well drilling rig into the jungles of New Guinea was described by Lawrence Marsh, chief petroleum engineer of the Standard Vacuum Oil Co. Using two Sikorsky S-55s the company transported a total of 1.5 million pounds of equipment to and from the drilling site—75 mi. from its base at Sorong. The copters made 1,134 trips with an average flight time of 32 min. Cost of the operation was $344,520 compared with $549,786 for the cost of a road.

Helicopter payloads now around the five-ton level, will go to a 30 ton level in the foreseeable future said Edward F. Katzenberger, Chief Development Engineer, General Design, Sikorsky Aircraft.

The S-56, now flying has a five ton capability. The machine recently set a record by lifting 5,000 kg. (11,000 lb.) to 12,000 ft.

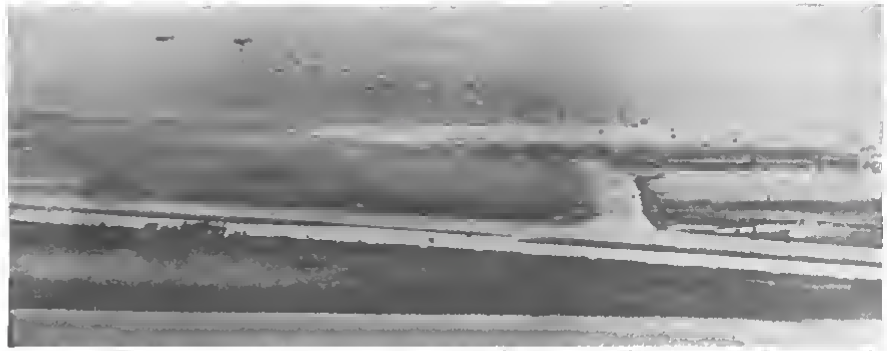
Katzenberger showed slides of some sketches of Sikorsky's thinking about future flying crane designs.

One model which shows enough promise for Sikorsky to have built a rough, wooden full-scale mock-up of the design has a front-located cockpit followed by a long thin flat section fuselage supporting main tail rotors.

First Missile Destroyer Commissioned by Navy

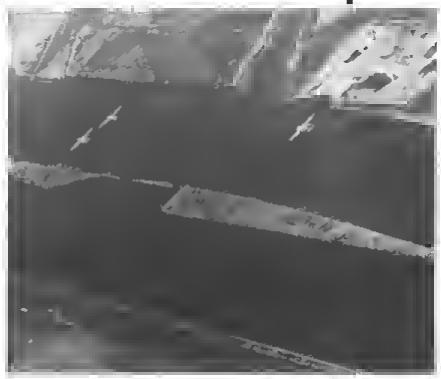
Washington—USS Gyatt, first of 16 destroyer type guided missile ships planned by the Navy is scheduled for commissioning today at the Boston Naval Shipyard.

The Gyatt equipped with a single twin launcher for Terrier guided missiles is also the first warship to have a stabilization system added to her hull structure. The system pioneered in Britain and already in use on several passengers liners, consists of two 45 sq. ft. retractable fins extending out from midships below the waterline to minimize roll.



TWO FRENCH Nord Noratlas transports drop paratroopers south of Port Said during Suez fighting. Drop zone is strip of dark land in foreground where some troops can be seen touching down. Light grey foreground is sandy marsh. Canal is on other side of drop zone. Pictures were taken by French photographer on mission, which was carried out by 25 Nord Noratlas airplanes. Five airplanes carried only materiel. Mission encountered very light ack-ack and no fighter opposition.

French Drop Troops on Port Said



NORD Noratlas airplanes flying over canal (left) waited for paratroopers to clear before dropping materiel (right) which included jeeps, 120 mm. mortars, 106 mm. field piece. Smoke (below) marks rocket attack on light Egyptian forces holding two bridges. Six French carrier-based Corsairs supported French troops endeavoring to cross bridges to get into Port Said. Tanks hold Port Said's water supply.

Impact of Wilson's Memo Will Be Known After Budget Hits Congress

By Evert Clark

Washington—Full impact of Defense Secretary Charles E. Wilson's "clarification" of Army and Air Force roles and missions will not be known until after the Fiscal 1958 defense budget reaches Congress—where interservice battles supposedly settled by the clarification are almost certain to be fought all over again.

There is growing feeling in the Pentagon that the new rules laid down by Wilson last week are neither as "mandatory" nor as permanent as he intended them to be.

Wilson said he issued his eight-page memorandum of clarification because the Joint Chiefs of Staff could not settle among themselves certain disputes—the main one revolving around control of the intermediate-range ballistic missile.

His memorandum appeared to give the Air Force control of the land-based IRBM, limit the growth of Army aviation, and keep airlift at about its present level. It also threatened cutbacks both in Air Force wing strength and in Army research and development.

The memorandum gave the Army control over USAF's Talos anti-aircraft missile and responsibility for "point defense," leaving the Air Force with the role of "area defense"—a job that would be carried out primarily by its longer-range interceptor missile, the Bomarc.

Officially, Army's immediate position was that it will try to live with the new rules.

All top level military and civilian Army officials refused to discuss details of the memorandum, however, until they could study it carefully and get what they called necessary interpretation of its fine points.

A number of high level meetings went on last week in an attempt to assess Army's real position as a result of the memo. Privately, both military and civilian officials in the Army pointed hopefully to a number of factors which they believe will keep the "clarification" from affecting them as drastically as it first appeared.

• **Reports that Wilson** is on the way out as Secretary of Defense are more widespread than ever. There was some feeling that the memo was a strong attempt on Wilson's part to settle the interservice rivalries which flared last spring (AW May 28, p. 26) before leaving office, although most Pentagon sources said it was simply an issue forced by the final work on Fiscal 1958 budget requests. At any rate Army feels a new secretary is almost sure to mean a new look at the Wilson memorandum.

• **Memorandum itself contains** a number of exceptions which Army looks upon as loopholes.

• **New technical developments** might call for considerable revision of the memorandum at almost any time. The memo itself even allows some room for that.

• **Rapidly changing international situation** could outdate the memo.

• **Congress has not yet had its say.**

• **Budget.** With an increase in international tension and no election to make budget balancing as important as it was this year, Defense Department budget requests are almost certain to be several billion dollars above those of Fiscal 1957. Army feels there may be less cutting back in some areas than the memo indicates, even at the Defense Department level.

The Wilson memo deals with what he called "five important problem areas which need to be cleared up." They are:

• **Army aircraft.** Wilson maintained the limit on fixed wing aircraft at 5,000 lb. empty weight, extended that limit to convertiplanes and vertical/short-takeoff and landing aircraft, which had no limits previously, and put a new limit of 20,000 lb. empty weight on rotary wing aircraft. He added, however: "Specific exceptions . . . for specific aircraft for specific purposes may be granted by the Secretary of Defense after consideration of Army requirements and appropriate Air Force functions and capabilities."

Army aviation is hard hit so far as future plans go, spokesmen said, but not with regard to current operations.

The combat zone, as defined by Wilson, is limited to "not more than 100 miles forward of the general line of contact." It "normally extends back of the front lines about 100 miles" but can be "designated by the appropriate field commander."

This conflicts with the Army's contention that battle zones in future wars will be several hundred to a 1,000 miles deep.

The Army is specifically excluded from providing aircraft for strategic or large-scale tactical airlift, tactical reconnaissance, interdiction of the battle field or close combat support.

Army aviation spokesmen have at one time or another advocated letting the Army handle all of these except strategic airlift.

• **Adequacy of airlift.** Wilson said the "current composition of the Air Force structure has been carefully examined and it appears that it presently provides adequate airborne lift in the light of currently approved strategic concepts."

Some Army spokesmen argue that they will be hard hit by this section of the memorandum. They say the Air Force has too many other worries—strategic bombing, air defense, tactical defense and attack, etc.—to want to give many budget dollars to airlift.

• **Air defense.** Wilson said the "present state of the art justifies development of point defense" missiles for use out to a horizontal range of 100 nautical miles.

Wilson gave responsibility for "development, procurement and manning" of point defense anti-aircraft missiles to the Army, including "the Nike I, Nike B and the land based Talos."

The Air Force gets the same responsibility with respect to area defense, including utilization of the Boeing Bomarc.

• **Tactical support.** The Army is to continue development of missiles for close support of field operations—but with the limitation that they be "designed and programmed for use within the zone of operations, defined as extending not more than 100 miles beyond the front lines." Wilson noted that the missiles probably would be deployed with the combat zone "normally extending back . . . 100 miles" and said this "places a range limitation of about 200 miles on the design criterion for such weapons."

This would leave the Army free to use all its tactical missiles up to and including the ballistic Redstone, which has a range of about 200 miles, and apparently means that Redstone Arsenal and the Army Ballistic Missile Agency will not be affected for some time.

• **Use of IRBM.** "Operational employment" of the land-based intermediate-range ballistic missile is to be "the sole responsibility of the U. S. Air Force," Wilson said. The Navy will operate shipboard intermediate-range ballistic missiles, and the Army "will not plan at this time" to operate the IRBM "or any other missiles with ranges beyond 200 miles.

"This does not, however, prohibit the Army from making feasibility studies in this area," Wilson said. Army officers, possibly grasping at straws, see the phrase "at this time" and the concession of feasibility studies as a hopeful sign.

Wilson took some note of Congress' warnings that duplication of defense efforts and spending must be avoided and said copies of his memorandum were being sent to appropriate congressional committees.

USAF Demonstrates B-52 Capabilities

Baltimore—USAF last week demonstrated the long-range capability of Strategic Air Command's B-52 bombers and crews in eight non-stop polar flights, the longest of which lasted 32½ hrs. and covered 17,000 mi.

Operation Quick Kick also emphasized SAC's round-the-clock readiness and the ability to set the eight jet Boeing Stratofortress down on civilian airfields in the event its own bases were destroyed in time of war.

Two of the planes landed in light snow on the 9,400-ft. runway at Baltimore's Friendship International Airport. The flights began on a Saturday morning and ended on Sunday afternoon.

Pilots found the Friendship runway adequate for the giant hydrogen bomb carrier, which had a landing weight of about 250,000 lb., but outrigger wheels at the ends of the 185-ft. wing hung over the edges of the taxi strips.

What Flights Revealed

The operation, involving four B-52s from the 42nd Heavy Bomb Wing at Loring AFB, Limestone, Me., and four from the 93rd Heavy Bomb Wing at Castle AFB, Merced, Calif., also revealed that:

• **SAC is confident** that the B-52 is combat ready, even though it never has pinpointed the exact cause behind the second Stratofortress crash near Castle two months ago. Fire in the forward wheel well was blamed on the electrical system and the cause was narrowed to four or five possibilities. Fixes were made and there have been no incidents involving the electrical system since.

• **Castle's 93rd Wing** is up to its full strength of 45 B-52s, and Loring's 42nd Wing will have 45 aircraft within a few weeks. The 42nd already has full personnel strength.

• **Pratt & Whitney J57-19 engine** with titanium compressor blades boosts later model B-52's climb and cruise capabilities to a point where earlier models have trouble keeping up with it.

• **SAC crews are eagerly awaiting** deliveries of Boeing KC-135 jet tankers. The number of refuelings with propeller driven KC-97s on Operation Quick Kick was not revealed, but Lt. Col. Marcus L. Hill, Jr., commander of the 93rd Wing and aircraft commander of Gumdrop 99, one of the planes that landed at Friendship, estimated that using the KC-135 would have cut at least three hours from his 31½ hr., 16,000 mi. flight.

Col. Hill's plane—The first B-52D produced—took off from Castle, flew east past Chicago, turned northeast toward a point east of Loring, made its

ROUTES of B-52 bombers in non-stop polar flights covering 17,000 mi.

CREW of B-52 which landed at Friendship International Airport, Baltimore, after record breaking flight. Left to right: Col. Donald Hillman, commander 42nd Heavy Bomb Wing, Seattle, Lt. Col. Robert Scott, Miami, Fla., pilot; Capt. Joe Bruce Bardwell, Tex., aircraft commander; Maj. Charles Cheever, Milford, Ill., navigator; Capt. Arnold Scott, Morristown, N. Y., radar observer; Capt. George Rolby, Detroit, navigator; Capt. Ralph Smiley, East St. Louis, Ill., electronic systems officer, and S/Sgt. John Nelson, Stockholm, Me., rear gunner.

simulated bomb run on Thule AFB, Greenland, flew over the North Pole, turned southward to Elmendorf AFB, Alaska, and San Francisco and then flew directly east to Friendship. Average altitude was 40,000 ft. Normal crew is six, but Gumdrop 99 carried nine. Col. Hill also commanded SAC's first B-52 combat crew.

Flight Route

The Loring plane carried Col. Donald E. Hilhman, commander of the 42nd Bomb Wing and leader of the four plane Loring flight, and was commanded by Capt. Joe B. Bruce. Its code name for the operation was Squad Car 1.

It flew from Loring to Goose Bay, Thule, the North Pole, Elmendorf, Seattle, San Francisco (its simulated target), Los Angeles, Abilene, Houston, Tampa, Key West, Miami, Atlanta, Washington and Friendship—a distance of 13,500 mi.—in 26 hr.

It carried eight maintained an average ground speed of 525 mph. to obtain maximum range and once hit a speed close to 700 mph. with a tail wind. Average altitude was about 35,000.

All eight planes broke the old record of 24 hr. aloft for the B-52. Record setter among the eight planes was commanded by Maj. Sam Morris. It took off with the Castle flight, covered the counterclockwise route over the pole and along the West Coast and then flew east to Loring, covering 17,000 mi. in 32½ hrs.

Tunnel Contracts Go To Westinghouse

Philadelphia—Westinghouse Electric Corp. received contracts totaling $3,300,000 to build components for three test wind tunnels.

A contract for $2,500,000 is for major modifications to extend capabilities of the 16-ft. transonic wind tunnel at the Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics.

Glenn L. Martin Co. of Baltimore awarded another contract valued at $800,000 for two wind tunnels, one transonic and the other supersonic.

All three projects are scheduled for completion in 1958.

Equipment for the tunnel at Langley will include a 35,000 hp. motor, an axial flow compressor and a switchgear and associated controls.

Under the Martin contract, Westinghouse will furnish drives and controls for two wind tunnels captured from Japan and Germany during World War II.

A two stage 2,500 rpm. axial flow compressor will be built to replace the Japanese tunnel's wooden compressor.

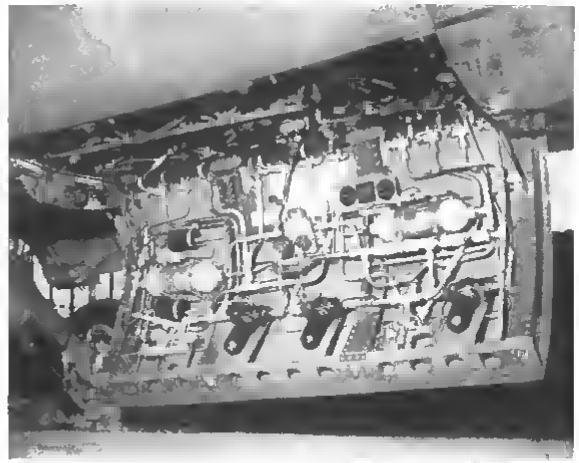
Lockheed F-104 Details

Lockheed test pilot Tom Levier stands in XF-104 cockpit at Edwards Air Force Base, Calif. F-104As and two-seat F-104Bs are now in quantity production at Lockheed's California Division. F-104 wings are 21 ft., 11 in. from tip to tip. Entire plane is 55 ft. long. Note negative dihedral, simplicity of cockpit canopy, which is extremely light weight. Pilot ejection is downward.

XF-104 WING has drooped leading edge to increase lift, boundary layer control and plain flap at trailing edge.

COCKPIT is roomy and visibility is good. Radar scope for fire control is directly in center, forward of stick which has numerous buttons for guns, rockets, etc. White headed throttle has button for speed brake. Top three instruments are machmeter, remote magnetic indicator and flight indicator.

HATCH of F-104 has been removed to show bottom of downward ejection mechanism. Nose gear retracts into fuselage in forward well.



EASY to get to hydraulic panel drops out of fuselage, just aft of the main landing gear.

Douglas Debentures To Raise $25 Million

New York—Douglas Aircraft Co.'s plan to make public offering of an issue of convertible subordinated debentures, expected to raise about $25 million in capital funds, is described by underwriters as an "insurance policy" by a conservative management looking to the future.

Douglas has an untouched $100 million line of bank credit, and the debenture issue, which would be junior to any future bank borrowing, would tend to enhance Douglas in any future bank loan negotiations. Probably the debenture issue will provide a larger term borrowing than a bank loan, which would appeal to the company. However, the issue will be convertible into stock at terms to be decided later.

The issue will be offered after the first of the year, sometime after the Douglas full year financial statement is available so that it can be used to support the sale. Other terms such as interest rates will also be disclosed later.

Douglas will use the proceeds to add to working capital for general use including costs of the DC-8 jet transport and plant facilities expansion programs. Up to now, costs of the DC-8 program have been paid out of current earnings, a policy which has kept Douglas net earnings from rising with its sales this year.

Neither the current tight money situation nor the pressure of DC-8 development costs were a direct factor in the Douglas debenture decision, the underwriters said, for it was not necessary for Douglas to borrow at this time. Kuhn, Loeb and Co. and Merrill Lynch, Pierce, Fenner and Beane are the managing underwriters.

Solar Aircraft

Solar Aircraft Co., which showed a $189,200 net loss in the first quarter of its fiscal year, had a net loss of $199,767 or 28 cents a share for the first half. This was in spite of a sales increase from $25.4 million for the first half of 1955 to $34.1 for the same 1956 period and an increase in backlog to $91.9 million compared with $53.6 million a year ago.

Besides a month-long strike at Solar's Des Moines, Ia., plant, mentioned as major cause of the first quarter loss, Solar blamed the first half decline on extensive engineering changes and resultant production difficulties together with higher than anticipated starting costs on certain items entering the manufacturing stage during the period.

Of the $51 million in new orders received in the latest six months, one-fourth were for Solar-designed gas turbine engines and controls. The balance

Northrop Trainer Designated T-38

Northrop's area ruled supersonic two-seat jet trainer (AW Oct. 1, p. 29), a prototype of which is to fly late in 1958, is designated the T-38.

Scheduled to support, then supplant the T-33A the T-38 is said to have take-off and landing characteristics equal to or better than the Lockheed jet trainer. Rate of climb is estimated at 30,000 fpm.

The T-38 will duplicate many of the flying characteristics of USAF's Century Series fighters, including very nose high takeoff and landing attitudes and high rate of sink approaches. FLYTAF currently sees a requirement for 400 T-38s.

included jet engine components, air frame assemblies, missile components, industrial expansion joints.

Solar declared its regular 25-cent quarterly dividend, payable Jan. 15 to shareholders of record Dec. 31.

Dividends

Dividends declared: Chance Vought Aircraft, Inc., 40 cents, payable Dec. 17 to stockholders of record Dec. 3; American Bosch Arma Corp., 25 cents and 5% stock dividend payable Dec. 31 to holders of record Dec. 5; and on preferred stock 5% cumulative series A and B, $1.25 payable Jan. 1 to holders of record Dec. 14; Lear, Inc., 15 cents, payable Jan. 10 to holders of record as of Dec. 20; Continental Motors Corp., 5 cents, payable Dec. 28 to holders of record Dec. 7; McDonnell Aircraft Corp. 12½ cents, plus a 3% common stock dividend, Jan. 1 to stockholders of record Dec. 17.

Wray: Atomic Defense Will Weigh Balance

San Angelo, Tex.—The atomic balance between the Soviet Union and the West will be broken by the first power to achieve an impenetrable defensive system that in effect cancels out the other's nuclear offensive capability and restores its own such advantage. Gen. Stanley T. Wray, chief, Electronics Defense Systems Division, Air Materiel Command, made this statement before the Texas Jet Age Conference here last week.

Gen. Wray said that the U. S. defense system comprising the vast Dew Line and SAGE complexes, will be substantially in being and have a high degree of capability within two or three years, giving this country the counterbalance necessary to establish our nuclear offensive capability.

Fund Lack for Bases, Jet Trainer Delay, Slow USAF Changeover

By Erwin J. Bulban

Laredo, Tex.—Lack of funds needed to expand basic facilities and slippages in the development of new aircraft are slowing the USAF Flying Training Air Forces effort to convert to jet operations.

Lack of jet trainers is hampering FLYTAF's mission because its current obsolete piston-engine fleet lacks high altitude, high-speed performance required to train students properly in tactical requirements for communications and navigation, subjects that rank high in its schooling program.

Current jet conversion programs entail phase-in of the twin-jet Cessna T-37A to replace the North American T-28A at the nine USAF primary flight schools operated under fixed fee plus cost contracts by civilian operators and replacement of World War II North American B-25 Mitchells by Lockheed T-33As at FLYTAF's three multi-engine basic pilot training schools at Vance AFB, Reese AFB, and Goodfellow AFB, Tex.

FLYTAF officers say that the T-37A is 18 months behind original schedules. Latest problem met about two weeks ago, was failure of the landing gear to pass static tests—a critical trainer requirement.

(Though the T-37A is 18 months behind original schedules, Cessna pointed out it is only about a month behind revised schedules. Time to make such changes as including ejection seats a requirement formed subsequent to the setting of the original schedule, was agreed to by USAF.

(Cessna does not believe the landing gear problem is a major one. The gear attachment to the wing reached 70% not the ultimate load, but Cessna believes it can beef up the structure to solve the problem.)

FLYTAF plans to get on with fitting the T-37A into its program while the changes are made. It expects its first T-37 any day, plans are to start a Phase 9 evaluation by instructors and students at James Connally AFB, Tex., in January where the training manuals for the airplane will be developed. It hopes to begin replacing T-28As with Cessnas at primary bases next fall.

Introduction of the T-37A at these contract schools will probably entail some expansion of runway facilities. The airplane can land in less than 3,000 ft., but for safety reasons longer runways at some schools will be necessary.

Need for longer runways is cited for delays in phasing in the T-33A for multi-engine basic pilot training. Of FLYTAF's three such bases, only Vance has converted to the T-33A.

Goodfellow and Reese AFBs are awaiting authorization to expand facilities. Funds have been appropriated by Congress to do the job, but indications are that the money may be diverted to what USAF considers higher priority requirements at other commands. Goodfellow's program, approximately a year behind schedule now, entails expenditure of $12 million, including two parallel 10,000-ft. runways. Its longest runway now is 5,400 ft., considered too critical for T-33A training, especially in hot weather.

Convincing students to make the Air Force their career is another high-ranking problem. FLYTAF estimates that the Air Force spends $120,000-$125,000 per man by the time he completes B-47 or Century Series fighter training. After completing a year of training, the Air Force can only be certain in most cases of another two years service by its new officers.

Air Force is losing almost as many officers as it trains, according to FLYTAF commander Maj. Gen. C. P. Disoway. "Its like pouring water down a hole," he said, referring to the replacement program.

A check of official FLYTAF data shows how heavy the attrition rate is among the new officers. Of a total strength of 32,365 first lieutenants in Fiscal 1955, losses in this grade came to 7,865 men, of whom 7,036 left the USAF after their first obligated tour of duty. In the first half of Fiscal 1956 a total of 4,846 first lieutenants in a total strength of 39,022 left 4,453 of these after their initial obligated tour.

Four officer separations, all grades, from the Air Force in Fiscal 1955 was 12,366 of a strength of 129,070, including 10,070 at the end of their obligated tours. In the first half of Fiscal 1956, separation in all grades totaled 6,745 officers, 5,582 at the end of their obligated tours. Separations other than at the end of the obligated tour were for reasons of death, retirement, hardship and similar causes.

To combat this heavy attrition FLYTAF stresses during its training that it is developing officers first, pilots second. Officer development programs receive high priority during the training program. Emphasis on the officer's role and future possibilities of growing with the Air Force is aimed at increasing the new officer's desire to make a career of the service.

Air Cargo Firms Need Sales Techniques

By Glenn Garrison

New York—Viewing the air cargo business as a future industry whose potential is "just around the corner" is seriously handicapping its present development, according to T. J. Harris, director of cargo sales for American Airlines. Addressing members of the American Society of Mechanical Engineers, Harris cited a veil of economic naivete in selling air cargo transportation as another roadblock in making the most of present opportunities.

New and better all cargo aircraft and ground handling facilities will not provide the complete answer to development needs, Harris said. While such equipment is needed and will lower ton-mile costs, air freight will never be truly competitive with ground transportation in terms of rates alone. What is urgently needed now is development of sales techniques based on sound economic knowledge of transportation costs in relation to other aspects of production and distribution, particularly inventory control.

Exotic Is Stressed

The just-around-the-corner climate in which air freight business now is developed is encouraged and sponsored by aircraft manufacturers who speak of performance and low ton-mile costs to come, but not yet here, Harris said. Others contributing to the problem include press and sales people who stress exotic and unusual products as suitable to air shipment and ignore the wide variety of practical commodities that must make up the bulk of air freight volume.

Failure to build sound sales techniques now, according to Harris, will hamper the industry when the awaited "corner" is turned.

Education is needed both in the sales departments of airlines and the offices of shippers, Harris said, if the "area of darkness" concerning the economic use of air cargo is to be penetrated. Inventory management and control information is meager, and traffic managers of industries often look at transportation from a parochial point of view.

Speed of transportation may not be the decisive factor for many shippers, but the proper combination of transportation and inventory control may determine the wisest choice.

Harris declared that forecasts for future air freight volumes don't allow for the dynamics of selling and development, and these too-low projections themselves hinder growth.

Citing a total of 800 million to one billion ton-miles annually by 1965 as the industry forecast, Harris called the figure a pittance and said only 20 jet freighters could handle such an amount.

Another speaker at the ASME aviation materials handling session, Port of New York Authority Aviation Director John R. Wiley, called the recently-opened cargo terminal at Idlewild Airport no "pushbutton" facility but said it had been designed for expansion and modification as air cargo handling needs required. As an example, Wiley pointed out, the asphalt ramp on the field side of the cargo buildings could be scooped out at relatively low cost to provide truck-bed level loading if needed.

Session chairman John Emery, Sr., president of Emery Air Freight, contended that part of the present air freight problem is "catching up with the market that already exists." Certificated air carriers according to the freight forwarding official, are not providing cargo transportation to enough points and are leaving "tremendous gaps" in the coverage of the United States.

"It's a tough job to get air freight moved on some of our airlines today," Emery claimed.

Late Peak Time

Difficulty of scheduling cargo flights so as to obtain best aircraft utilization was under discussion at the session. According to Harris, the increasing amount of freight forwarders' business delivered to the airlines tends to move the peak time later in the day because of the time required for the forwarders to consolidate shipments before sending them out to the airlines.

Emery said, however, that while "you used to be naive if you thought the shipper would make his freight available at any time but 4:30 p.m.," more than half of his organization's customers now release their shipments at various times of day instead of peaking in the afternoon.

An engineered approach to the design of air freight terminals and their location on airports was called for by Charles F. Dworshak, sales and traffic director of Slick Airways, in another ASME session on "airport planning."

Present air freight terminals are comparable to truck terminals, Dworshak said, without adequate docks, buildings or conveniences. Only a very few air cargo terminals have been designed for their purpose and those haven't been tested in lengthy practice yet, according to the Slick official.

Passenger facilities at most airports also were given tough treatment during the panel discussion, and new concepts in providing facilities for the 'forgotten man' of air transportation—the airline passenger—were called for by several panelists.

Baggage delays, inadequate roads to airports, remote automobile parking areas, long walks in boarding aircraft, lack of protection from weather, poor waiting room facilities, insufficient hotel accommodations and ramp delays were among the inconveniences the passenger was said to face.

New Methods

Standardized passenger terminal design was described as an impossibility by B. C. Rathbone, functional engineering manager of Trans World Airlines who said the characteristics of each community and its airport must be considered in designing such facilities.

Rathbone also cited disadvantages he said were involved in several new methods of moving passengers to their aircraft. The aircraft docking principle, he said, would become a mechanical monster if it were used to handle both swept wing and conventional wing planes. Swept wing planes also would create problems with the movable bridge type of device, Rathbone said, and use of vehicles to carry passengers to aircraft would increase ground time at intermediate stations by 20 to 30%.

Nevertheless, the TWA official said, his airline was watching such experiments with interest.

Each airline at New York International Airport will have new responsibility in handling its passengers on the ground under the decentralized terminal concept, Thomas M. Sullivan, Port of New York Authority aviation planning chief, pointed out. In Idlewild's new terminal setup airlines will operate their own individual terminal buildings and provide the passengers' waiting room, restaurant and similar facilities.

Sullivan said the Port Authority is relying on the aircraft manufacturers to prevent major problems such as noise in handling jet transports at airport terminals. The Port Authority has banned jets at their present noise levels from the airports under the agency's jurisdiction.

Struggle for Control of ACTA Gives New Strength to Rival

By Craig Lewis

Washington—A shift in strength between the two supplemental airline associations has resulted from the internal struggle for control of the Air Coach Transport Assn which broke out a month ago (AW p 12 p 25)

The dissident group that took over ACTA's management in a sudden coup has consolidated its position with the election of a new board of directors, and four dissatisfied carriers have left ACTA and joined its rival the Independent Military Air Transport Assn

At a general meeting in Washington last week, the ACTA membership elected a new board to replace the one that resigned a month ago The new board headed by Ralph S Cox, Jr., consolidates the insurgents' control

With U S Overseas Airlines President Cox as chairman the new board also includes Fred R Adams, of Central Air Transport George S Patterson Great Lakes Airlines Irving Mansfield, Westair, and E J Averaman, Jr, Reguna Cargo Airlines

ACTA Resignations

Unhappy with the recent revolution and the new management, four ACTA members resigned last week and switched their allegiance to the Independent Military Air Transport Assn The new IMATA airlines are General Airways, Los Angeles Air Service, Meteor Air Transport and Modern Air Transport

Last week's move to IMATA gives the organization new strength and puts it in a better position to compete with ACTA and the Air Transport Assn for the military charter business that is the lifeblood of most supplemental airlines

IMATA regains some ground in last week's move that it lost earlier this year when Slick Airways and the Flying Tiger Line withdrew their aircraft from the IMATA fleet and joined ATA At the time IMATA's future seemed uncertain

The two supplemental air line associations solicit military traffic for their members under exemption authority from the Civil Aeronautics Board, and the uncertain future of ACTA raised speculation that its exemption might not be renewed

However the CAB renewed the exemptions for both ACTA and IMATA until Dec 1 1957 The Board pointed out that the military need for commercial services still exists and decided to extend the present arrangement

The dispute in the ACTA membership which resulted in the resignation of four carriers burst out suddenly at the end of October when a group of airlines which were unhappy with ACTA policy met and decided to assume control

With the help of the five individual carriers in the Trans American combine the dissident group marshalled the support of 10 carriers and appeared in the ACTA offices on Oct 29, announcing that they were taking over

At that point, control of ACTA shifted to a management group which included Cox, Donald Hotrup of Trans American and Amos Heacock, long a stormy figure in nonscheduled airline circles Heacock is a former ACTA president, but he has been away from the Washington scene for over three years Air Transport Associates Heacock's airline was put out of business by the CAB in 1951 for flying a frequent scheduled service between Seattle and Anchorage without authority

ACTA President A J Rome resigned immediately after the coup as did several staff members and six of the seven directors The new group has continued to run the organization, but not without difficulty

Insurgents' Plan

Heacock, Cox and their associates maintain that ACTA needs more aggressive leadership than it was getting from the Rome group The new group has met with Defense Department officials in an effort to promote more military business and they are expected to continue to use a vigorous approach

Heacock's group is trying to persuade the Defense Department to stress the time-saving element of air travel more heavily in bidding for contracts Objections were raised to package bidding and requirements that pressurized equipment be used on overseas charters The group also asked for access to individual and small group military traffic

The old management preferred a more diplomatic approach to the Defense Department and felt that it was untimely to become too aggressive when there were promising signs of improvement for supplemental airlines under the military single management system now going into effect

CAB's Role

The membership rosters of both ACTA and IMATA will be finally determined by the CAB when it rules on the member carriers' applications for authority as supplemental air carriers Last July, CAB Bureau Counsel recommended that 33 of the 54 applications on file be denied

The status of the carriers is currently clouded by a court decision which resulted when the scheduled airlines appealed the decision of the CAB a year ago to grant substantial new authority to a new class of airlines called supplemental air carriers

The court found that the CAB failed to show sufficient evidence to support the granting of interim operating authority in exemption form to the nonscheduled airlines while awaiting a decision on their applications

After some extensive legal maneuvering, the CAB has obtained a breathing period in which it must make up its mind on what steps to take next to provide authority for the nonscheduled airlines That decision must be made by Dec 28

Pilot Fatigue's Role in Accidents Debated at Geneva Civil Air Meet

Geneva—Pilot fatigue and the part it plays in airline accidents highlighted the opening sessions of a two week conference on civil aviation which began here last week under the sponsorship of the International Labor Organization

The conference is being attended by 20 delegates from 13 nations representing both employers and employes in civil aviation The agenda is largely devoted to problems involving flight crews and the delegates will grapple with the touchy subjects of pilot flight time and working hours

These items were argued at the recent Air Line Pilots Assn biennial convention in Chicago but no firm conclusions were reached (AW Nov 19, p 39)

A report presented to the Geneva delegates by the International Labor Office urged the adoption of standard flight time limitations to provide an adequate reserve of pilot efficiency and stamina to serve as a buttress in the event of emergencies

The report emphasized that there are no detailed international standards governing work hours or flight times of crew members at present and warned that the framework of standards of the International Civil Aviation Organization are so broad that misinterpretation resulting in abuse can result

While the report concluded that flight crews can reach a danger point of fatigue through long consecutive hours of duty, it admitted that no criteria yet exists for determining the point at which the average pilot will experience fatigue

Investigation findings of 12 accidents in which pilot fatigue was suspected as a contributor cause were cited The report conceded, however, that other factors may have been responsible for the accidents and added

It is unfortunately never possible to carry out scientific tests for fatigue on those who have been involved in accidents because if they survive the accident the shock effects would invalidate any fatigue tests that could be devised

Flight Time vs. Safety

Several extracts from official accident reports were included in the report to illustrate the possible effect of long flying hours on safety For example "The crew had been on almost 24 hours continuous duty, including about nine hours flying which must have contributed to fatigue"

In another case in which the crew had been on duty for 22¼ hours including 19 hours, 55 minutes of flight, the report said "It appears possible that he (the captain) was feeling the effects of considerable fatigue just when after a lengthy flight, he had to undergo the tension in landing operations in unfavorable weather conditions"

The report said that it is not enough to consider only the hours flown in analyzing the impact of fatigue It cited a previous study by the International Air Transport Assn in which fatigue was attributed to such factors as weather conditions, mechanical defects, long ground delays private worries and "burning the candle at both ends"

The ILO report also said that laboratory experiments conducted by the Applied Psychology Research Unit of the British Medical Council indicated there is "no simple relation between the frequency of errors and the length of time during which work had been continued, as would have been necessary if fatigue were to be accepted as an explanation"

ALPA's Stand

The International Federation of Air Line Pilots Assns however contends that the 'accident potential increases with the extension of flight duty beyond eight hours"

Although the Air Line Pilot Assn presented comprehensive studies of flight time and working hours at its biennial convention, the fatigue element was not raised as an issue ALPA delegates appeared to be more interested in working conditions (time away from home) than in flight time ALPA, however, may seek a working conditions formula that could result in a reduction of flying hours to as low as 30 or 40 hours a month if a number of its demands are not met by the airlines U S pilots now fly 85 hours per month

The Geneva report noted that, while limits are placed on flying hours of flight crews there is very little regulation governing total hours of duty The International Civil Aviation Organization defines flight time as "block to block time Hours of work are defined in the report as "time during which persons employed are at the disposal of the employer"

Flight time is governed by legislation in some countries, by collective bargaining in others

Limitations of flight time in India are established solely by company regulations

The report also pointed out the lack of constant relationship between concepts of duty hours and flight time By way of illustration, it said some short haul flights may involve no more than two hours duty time in addition to flight time On the other hand hours of work on other short-haul flights can be very long in relation to flight time

For example, four daily short flights of two hours each resulting in eight hours flight time can result in 12 hours duty time

There are few examples of legislation or agreements that limit hours of work of flight personnel, according to the report

ICAO Proposals

ICAO has proposed a limit of eight hours of uninterrupted flying in any 24 hours Regulations embodying this principle with certain variations have been adopted by Australia, Finland, France, New Zealand, Pakistan Switzerland, Union of South Africa and the U S

ICAO has suggested 100 hours for aircraft carrying a crew complement of one or two pilots The 100-hour limit is used in Argentina, Colombia, New Zealand, Norway Union of South Africa and the U S on international flights

Monthly total of 125 hours is proposed by ICAO on flights carrying two pilots and an additional crew member This ruling is in force in Argentina Australia, Brazil, Finland, Greece, Japan Pakistan, Union of South Africa, United Kingdom and the U S

The report made clear that the Geneva meeting is empowered only to make suggestions and recommendations on civil aviation labor matters The International Labor Office however, presumably will present findings of the meeting to ICAO and consult with that body on measures that may require extended action

Aero-Medics Say Decompression Will Be Greatest Jet-Age Problem

Wright-Patterson AFB, Ohio—Explosive decompression is the most serious medical problem in the coming operation of jet passenger transports, according to a panel of experts at the Aviation Medicine Symposium conducted by USAF's Air Materiel Command

The panel also discussed the problem of ultrasonic sickness, and it was suggested that a noise standard be set for the interiors of jet transports to guard against the possibility of physical damage to occupants.

The discussions were conducted at the aviation medicine conference held at AMC headquarters The panel included Brig Gen Odis B Schreuder (USAF Ret) director of medicine for Pan American World Airways' Atlantic Division, Dr Donald Stuhring Department of Preventive Medicine Ohio State University, Maj Stanley White, Aero Medical Laboratory, Wright Air Development Center, and Maj Joseph M Quashnock, School of Aviation Medicine, Randolph AFB, Tex.

Discussing explosive decompression, Maj White compared it with the detonation of 100 lbs. of explosives inside the cabin The problem occurs when there is loss of pressure in an aircraft at altitudes when pressure is decompressed in less than ½ second so that the lung cannot be "dumped" or equalized at the same rate as the decompression

White said that there were 51 cases of decompression in commercial air travel between February 26 and May 26 of this year He pointed out however, that these were cases of rapid decompressions None were explosive

When explosive decompression occurs above 25,000 ft an immediate descent must be made to protect the passengers White said He added that a passenger not strapped in his seat during a descent of 15,000 fpm becomes a "missile"

White favored consideration of liquid oxygen systems for commercial aircraft in the interest of passenger safety

BOAC, BEA Investing $668 Million

British Overseas Airways Corp investment in aircraft will total more than $500 million when current orders are filled, including those for the Boeing 707 and de Havilland 118. British European Airways Corp investment will approach $168 million.

These figures were put before the House of Commons this week by the government. The combined cost of Boeing jets and the DH 118s was given as $280 million.

On the basis of the previous figure given for the Boeing purchase of $123 million, including engines, this would mean an investment of $157 million in the new de Havilland jet. This could mean a fleet of 20 or more DH 118s. The government said BEA could be expected to invest in helicopters and a small number of jet aircraft for longer routes during the next five years.

During debate on a bill which would increase the borrowing power of the state airlines, strong demands were heard that British Airlines in the future should be required to buy British aircraft only. Minister of Transport Harold Watkinson replied that, "There is no real break in the general policy of buying British whenever we can, but if we are to sell aircraft in the world then I think we cannot just refuse to buy ourselves anywhere."

The government disclosed that as much as one third delivery costs may be paid to Boeing before any of the fifteen jets on order are delivered. Watkinson said close study would be made of the Princess flying boats now cocooned to see if they could be put to use.

During the course of the debate one of the strongest criticisms yet heard was made of the Britannia when one member asserted: "It would appear that perhaps the most suitable role for the Britannia at present would be for it to be sold in the export market as a troop carrier to a potential aggressor."

Military, Airlines to Cooperate on Airports

New York—Critical airport problems faced by the Air Force in operating heavy jets soon will confront commercial aviation, Maj Gen Lee B. Washbourne, Asst. Chief of Staff, Installations, pointed out in a recent New York address. Speaking to members of the Metropolitan Section of the American Society of Civil Engineers, General Washbourne called for continued cooperation between civil and military engineers in planning airport design and construction.

Describing Air Force experience with some of the major problems, the officer cited:

- **For noise abatement,** a method of reducing ground runup noise is "virtually at hand" and will be instituted within the next few years. There seems to be no prospect, however, for "any great reduction" of noise produced by jets in flight. One new test stand for engines of 40,000 lb. thrust will cost the Air Force about $700,000. Soundproofing will have to be provided for facilities housing such noise-sensitive functions as communications, briefing rooms and the like. "This may be accomplished through double partitions, suspended ceilings, double windows and absorptive liners."
- **To handle increasingly heavy jets,** runways at some Air Force fields have grown from the general 150 ft.-wide, 4,000-6,000 ft.-long strips of World War II to heavy-duty runways up to 15,000 ft. long and 300 ft. wide with reinforced shoulders. Primary base size has increased from about 1,200 acres to 5,000 acres. Pavement thicknesses are being increased by as much as 40 to 50%, now requiring 24 in. of concrete in some cases.
- **Protection** of personnel, ramps and runways against jet blast will require widespread use of blast fences. One Air Force base already has asked for more than 9,000 feet of blast fence construction. Jet blast raises pavement temperatures to as high as 1,000 degrees at runup, but even more trouble some are blasts caused by lower power settings because this range of engine operation takes place over widespread areas. The areas include aprons, taxiways and parking pads, can injure personnel, damage equipment and erode unsurfaced areas. Over an unsurfaced area the jet blast scatters debris and dust which can cause severe damage to turbines when sucked into jet engine intakes.
- **Ground handling** of jets may require "some entirely new concept" of moving and servicing. The Air Force expects to use hydrant fueling systems almost universally and to develop adequate flush lighting.
- **The practice** of converting military aircraft designs to commercial use will continue and providing runways, navigation and maintenance facilities to support their operation will require "close exchange of ideas" between civilian and military engineers.

Progress in the development of vertical takeoff and landing and short takeoff and landing aircraft was noted by General Washbourne as a "bright spot" in the airport construction picture. These planes will permit great reductions in runway pavement areas, grading, clearing, real estate and lighting requirements, he said.

Northeast Washington Facilities

Congestion at Washington National Airport forced Northeast Airlines to locate its operations office in an automobile trailer to handle its new service into the capital which began on Nov. 27. Northeast Airlines also had to locate its ticket counter in wing of a building north of the main waiting room, where ticket counters of most airlines are located. Wing will be shared with Delta Air Lines.

Aeroflot Programs More Jets, Lower Fares for '56 Operations

Moscow—Soviet Russia expects fast growth for its jet transport operations next year when Aeroflot expands jet services and introduces new, high capacity equipment.

Along with this expansion, Aeroflot expects to cut jet fares, which now command a 7% premium, according to Nikolai Ochnev, deputy chief of the Russian airline.

Aeroflot hopes to have three new jet transports ready for service next year when more jet routes will be inaugurated, Ochnev said. The three new transports are a 70-passenger version of the Tu-104, and 95 and 170-passenger jets designed by A. N. Tupolev (AW July 9, p. 26).

This year a 70-passenger, twin engine turboprop plane designed by Antonov was demonstrated at the Moscow Air Parade (AW July 2, p. 26). However this model did not satisfy us and for that reason he is designing a special four engine turboprop plane for operation on international routes," Ochnev said.

Jet-Age Planning

The Aeroflot official said some airports are now being re-equipped and new ones are being built in anticipation of expanded jet service and that the entire meteorological service is being reorganized. "Nor are we lagging behind with the training of experienced flying personnel, navigators and technicians for operations of these new jet planes.

"I would like to say that travel in these jet aircraft will be much cheaper than in the conventional types. The question is already under consideration."

Aeroflot's 40 passenger Tu-104s already have made a reputation for themselves in regular service, according to Ochnev.

"With them, we have made a sudden stride from planes with two internal combustion engines to jet planes, bypassing the employment of four and six engine airliners on our routes."

New Routes Planned

This is the distinguishing feature of our civil aviation. Moreover, it is virtually only in the Soviet Union that jet planes are being employed for internal and international routes.

The Aeroflot official said the carrier hopes to open regular through service between the USSR, India and Burma "quite soon." A Tu-104 proving flight on the Moscow-Delhi-Rangoon route, crossing the Himalayas, was made in October.

"When this route is opened," Ochnev said, "passengers will no longer have to fly to Rangoon or Delhi via Scandinavia and the Near East. We are now also negotiating with several European and Eastern governments to open direct air communications."

New Bureau Head Appointed by CAB

Washington—John M. Chamberlain, director of the Civil Aeronautics Board's Bureau of Safety Regulation, has been relieved of his position at his own request and has been replaced by Oscar Bakke, the former deputy director.

Chamberlain asked to be relieved of the directorship because of ill health, and the CAB "regretfully complied." He has switched jobs with Bakke and will remain as Deputy Director.

Chamberlain joined the CAB in 1942 after serving with the Civil Aeronautics Administration and the Bureau of Air Commerce. He became director of the Bureau of Safety Regulation at the time it was established in 1948.

Bakke has been with the CAB since 1946, serving in various safety offices. He was appointed deputy director of the Bureau of Safety Regulation in 1954.

CAB Announces Close Of N. Y.-Florida Case

Washington—Civil Aeronautics Board has brought the long and bitterly fought New York-Florida Case to a close by refusing to reconsider any of the major decisions made last August.

With the exception of two minor awards, the new services granted by the Board in its New York-Florida decision have gone into effect. Northeast Airlines, the big winner with a new route to Miami, already has extended its services as far south as Washington.

The CAB decided to deny all petitions for reconsideration and proposals for more service filed last month (AW Nov. 12, p. 41) with two exceptions.

The Board withdrew the authority it granted Delta Air Lines to operate a new Augusta-Tampa route and the authority granted to National Airlines to serve Greensboro-High Point and Winston-Salem, N. C.

When it decided the New York-Florida Case in August the CAB authorized Delta to operate a one-stop

New TWA Hangar at Kansas City

New Trans World Airlines hangar which can hold 10 large aircraft at one time is going up at Kansas City Mid-Continent International Airport. Building is 65% complete. Web of steel scaffolding supports forms used in pouring overhanging bay roof. This is supported from center pylon by steel cables. Hangar is 1,000 ft. long, 420 ft. wide. Right is completed main administrative office.

service between Tampa and St Petersburg-Clearwater, Fla and points on the carrier's Atlanta-Chicago route Now the Board has reversed itself and the route will be considered in the Great Lakes-Southeast Case

The August decision also added Greensboro-High Point and Winston-Salem to National's route, duplicating existing service by Capital Airlines and Eastern Air Lines The CAB has now decided to defer its decision on this issue and to conduct an investigation to determine whether Capital or National or both, can best meet the requirements of the two cities

Havana Plans $2.5 Million Heliport

Havana—Plans for the immediate construction of a $2 5 million helicopter terminal building in the heart of Old Havana were announced here this week The terminal according to local reports will be the second in Latin America the other being in Montevideo Uruguay

The terminal will be constructed on 4 000 sq meters of land three blocks from Havana harbor It will provide both passenger and cargo service between Havana and surrounding towns and cities in Cuba

The structure will be a four story building with the roof serving as a landing field for the copters Bottom floor of the building will be given over to small businesses and the three top floors to offices A garage in the basement will provide parking for 200 automobiles

The terminal is expected to be completed by the end of 1957 Heading the helicopter firm Terminal Del Helicopteros, S A is Vladimiro Kresin Cuban business man

PanAm Reports Profit For First Three Quarters

Pan American World Airways reported net profit of $12 722 000 for the first nine months of 1956 compared to net profit of $10,307,000 for similar period last year Operating revenues were $216,588 000, compared to $179 273.000 in 1955—an increase of 20 3% Operating expenses rose 18 3% over the same period last year

SHORTLINES

► American Airlines' October passenger traffic registered a 12% increase over that of October 1955 American flew 449 million passenger miles during the month

► Bendix Airborne Weather Radar has

AIRLINE OBSERVER

► Boeing Aircraft and airline officials will meet within the next six months to tackle critical problems involving ground equipment needs for jet-transport operations Field tests will be conducted with the Boeing 707, and major vendors will be invited to demonstrate various types of ground equipment. Matters on which airlines are anxious to make a decision in order to begin long-range planning of jet ground handling include best types of engine starting, engine removal equipment and aircraft towing systems.

► Sabena Belgian World Airlines has taken delivery of the first of 10 DC-7Cs. It will place the new transport on scheduled service over the New York-Shannon-Brussels route in January The airline plans to place its DC-7Cs into non-stop New York-Brussels service early next summer.

► Douglas Aircraft will increase deliveries of DC-6s and DC 7s from 10 to 15 aircraft per month next year in a move to cut down backlog orders that now total more than $1 billion in commercial transports for the highest commercial backlog in the company's history

► Western railroads have asked the Interstate Commerce Commission for a 5% increase in first-class passenger fares in an apparent move to spike an earlier bid by eastern railroads for a 45% fare increase Western companies fear the big tariff boost will have a damaging effect upon the all-important interline transcontinental traffic and hope the request for a 5% increase will encourage eastern lines to drop their demands to a more reasonable fare level.

► Eastern Air Lines estimates that employe replacements and additions will total 4 800 during 1957 Turnover of personnel from January through October of this year amounted to 2,800, and the airline expects the 1956 total of new employes to reach 3,800

► U.S. airline sales officials will intensify promotional activities in Europe as a result of the mounting volume of tourist travel to the U S. One estimate puts the number of tourists visiting the U S. from Europe, Canada and Latin America at one million annually. It also is estimated that approximately $700 million is spent each year for this travel, exclusive of local border traffic

► Lockheed and Douglas are charging off development costs against current earnings and as a result, may show profit declines this year. Lockheed estimates development and experimental costs for the year will total $14 million, of which about $12 million is chargeable to the Electra Douglas development costs reached $16,700,000 during the first nine months of its fiscal year which ended Nov 30 Bulk of the increase is attributed to the DC 8

► Airlines are concerned that designs of new terminal buildings planned for such international airports as Los Angeles, Honolulu and Miami may not include proper custom and immigration facilities Because of the expected increase in traffic, airlines fear ground handling of international passengers may bog down unless streamlined inspection procedures are incorporated into the original designs.

► United Air Lines may establish a total of five regional sales areas in a projected reorganization of its sales department Regional offices already have been opened in San Francisco and Los Angeles to cover the western and southwestern regions Long-range planning includes regional offices in Chicago and New York, with the fifth probably going to Seattle. No target date has been set for completion of the overall program

► No-show problem has not improved since adoption of phase one of the ticket-pickup plan which went into effect on Sept 16, according to a sampling program conducted from Oct. 14 to Oct 20 by the Air Transport Assn However, the airlines will form no definite conclusions on phase one until it has been in effect for at least 90 days

been ordered by Capital Airlines, Northeast Airlines and Varig Airlines of Brazil. Capital is installing the radar on its Viscounts. Northeast will use it on the 10 DC-6Bs it has on order. Varig will install the radar on its 1049G and 1649 Constellations.

▶ **Braniff Airways** will begin using its modified DC-6 transports Dec. 10 on flights to South America. Braniff has modernized its DC-6s under a $1,150,000 program which included installation of Pratt & Whitney CB-16 engines. The new engines have increased the transports' capacity by 85% on U.S.-Argentina flights. Braniff has received the first of five Convair 440s on order.

▶ **British European Airways** reports increased revenues, traffic and capacity for the summer of 1956. In the April-September period, BEA's revenues increased 10.7% to $41,410,000, and passenger miles were up 15.3% to 525,276,000. Capacity was increased 15.8% to 54,848,000 ton-miles. The revenue load factor dropped from 65.9% in the previous summer to 65.3% last summer.

▶ **Central Airlines** begins service today on its new Denver-Oklahoma City and Amarillo-Wichita routes. Central will operate one round trip flight over each route every day but Sunday.

▶ **Colombia's largest airport** has been opened at Barrancabermeja to aid oil exploration in the area and to serve as an alternate for international flights to Bogota and Barranquilla. The airport has a 5,904-ft. runway designed to handle takeoff weights of up to 133,000 lb.

▶ **Eastern Air Lines'** flight simulator instructors have decided to authorize the Air Line Agents Assn. to represent them.

▶ **Ozark Air Lines** carried 34,662 passengers, 127,743 lb. of air mail, 304,413 lb. of express and 184,671 lb. of freight in October for a company record in all four categories.

▶ **Seattle-Tacoma International Airport** handled 110,033 passengers in October, an increase of 11% over October 1955 traffic. Air freight traffic increased 24% to 3,020,508 lb. in the same period.

▶ **Southwest Airways'** president John H. Connelly is touring European aircraft factories to inspect turboprop transports being offered to the local airlines as replacements for their piston equipment. Connelly is conferring with Fokker on the F-27, with Vickers-Armstrong on the Viscount and with D. Napier & Son, Ltd. on the Napier Convair conversion.

COCKPIT VIEWPOINT

By Capt. R. C. Robson

Automatic Communications

One of the best estimates of our aeronautical future was served up at Washington National Airport recently. A pilot in the number two position for takeoff grumbled about the long delay and inquired of the tower, in a peeved voice,

"What are you guys going to do in a few years when traffic doubles?"

Quick as a flash came back the answer,

"Make you number four for takeoff."

It is unquestionably true that until we get some sort of an automatic communication system in operation we are going to see continuous deterioration of the traffic situation. On the night of Oct. 31, for example, I sat at the ramp, with engines running, for twelve solid minutes with microphone in hand trying to get in a call to the LaGuardia Ground Controller.

Traffic Deterioration

Only a week before I had taxied out, was cleared into position and for takeoff, and left the area without once contacting the tower. Other aircraft also took off and landed while many circled overhead. Yet for five minutes there was no reply nor transmission from any aircraft.

Why? Because in order to keep the operation running the tower controller had to talk continuously and assume that aircraft were hearing him and complying. Had he stopped for replies, traffic too would have stopped.

Perhaps this doesn't sound like much on paper, but it is impressive via a plane radio in the midst of a snarl. It is a tribute to that controller that landings and takeoffs were accomplished speedily and orderly. It is also a graphic illustration of why we need automatic message transmission quickly.

Many airports have long passed the saturation point using today's radio techniques. Only alert pilots and controllers, plus a measure of luck, can keep things moving. Only an all-out program on automation in the communications field will keep them moving in the future.

But—and here is the crux of the matter—who is going to do this? Remember the VOR-Tacan hassle? It is entirely possible that automatic message transmission will produce an even bigger fight. Like Vortac, this fight may be fought more on political operational grounds.

Many Techniques

There are many techniques in operation today which can be used to help our communications problem. There are memory storage tubes, magnetic tapes, television and many other processes. There are various government agencies and manufacturers who are going to fight jealously for their pet. It is doubtful that the CAA has the power to arrive at any sort of a firm decision as to which process or which gadget to use. So it is entirely possible that the most important thing in aviation, automatic messages, may be far in the future.

Each year aircraft increase in both numbers and speed. Pilots realize that it is necessary to "stay ahead" of the aircraft in order to operate safely. The same realization must be made regarding communications. Clearances must be delivered faster and arrive on time; weather and airport information must be speeded up. Position reporting must be almost instantaneous. This cannot be done with present hand-mike techniques.

Some of the stuff in the last two columns may sound like old hat—it has been printed before. But it is still valid. Despite the publicity given to the air traffic control problem, conditions at the local airport and en route are getting steadily worse.

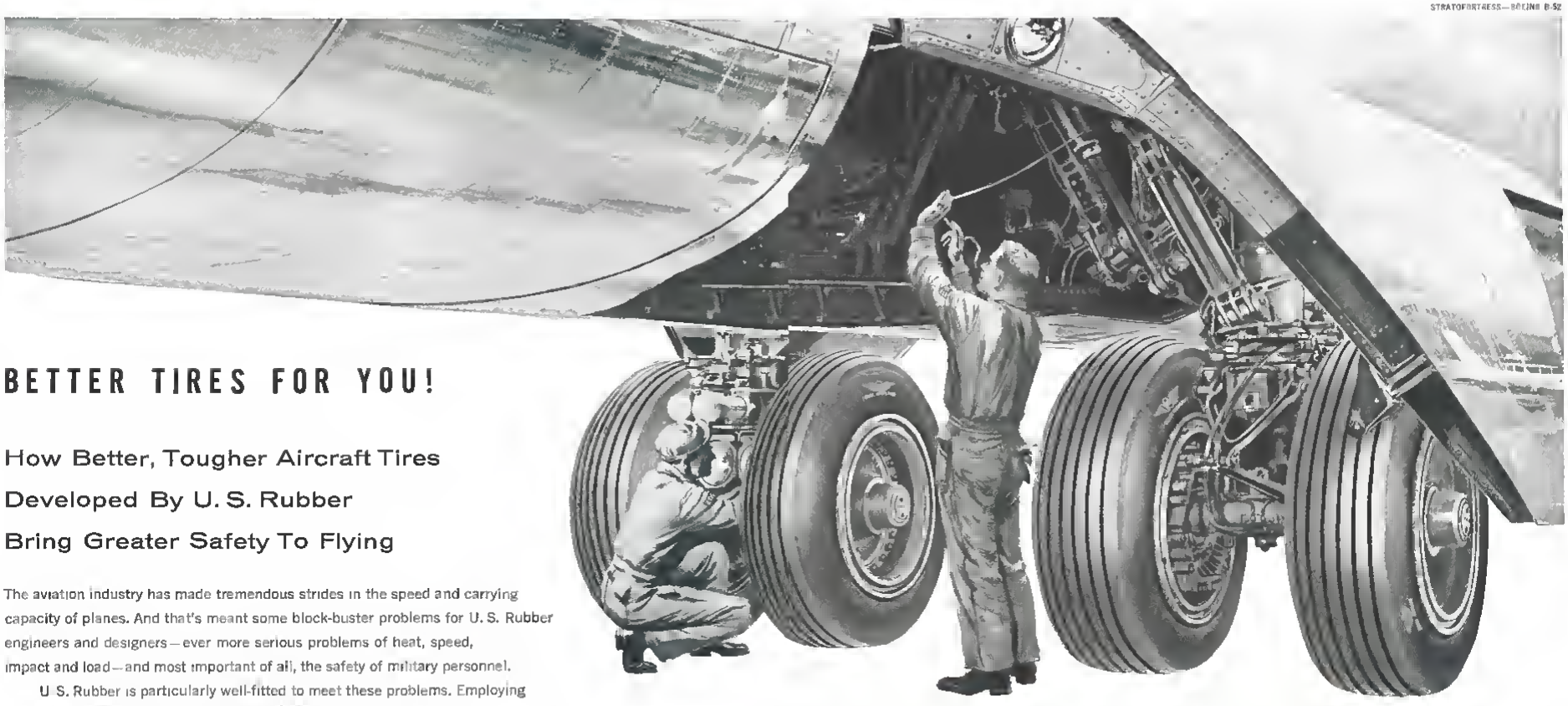
Airline Traffic — Third Quarter 1956

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor	U S Mail	Express	Freight	Total Revenue Ton-Miles	Per Cent Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	2,017,764	1,325,213	68 95	4,628,021	2,678,288	18,949,560	153,269,021	59 92
Braniff	434,133	178,351	59 96	648,973	382,857	1,059,497	19,166,476	53 10
Capital	811,504	280,293	58 03	823,242	609,738	931,413	29,190,670	44 45
Continental	183,746	69,109	56 05	211,414	81,578	306,575	7,233,044	47 38
Delta	575,914	270,762	56 36	879,569	847,080	1,790,227	29,535,129	52 35
Eastern	1,816,804	875,427	58 17	2,689,986	1,358,012	3,727,485	98,479,088	45 39
National	280,014	183,432	62 21	630,947	126,743	1,010,238	20,446,334	60 63
Northeast	212,067	42,407	60 69	30,676	56,612	98,283	4,832,365	56 71
Northwest	367,483	259,704	66 04	1,135,393	716,816	2,054,714	29,359,453	56 49
Trans World	1,096,766	930,461	69 88	2,877,964	2,339,895	5,877,101	166,189,909	62 83
United	1,700,807	1,225,455	70 74	6,035,198	3,343,292	14,081,536	141,259,867	61 50
Western	309,745	159,129	63 91	645,798	254,461	492,378	16,609,768	55 33
INTERNATIONAL								
American	38,429	27,908	67 46	36,175	2,273	924,017	3,618,761	66 25
Braniff	8,605	18,715	53 67	52,316		188,086	2,358,671	56 68
Caribbean Atlantic	44,134	3,082	61 27	3,161		18,751	299,276	59 69
Delta	15,418	17,713	64 53	19,400		103,933	1,955,273	51 04
Eastern	79,924	104,800	69 75	166,900	234,317	105,234	11,758,724	61 57
National	23,872	11,932	47 15	21,971	11,983	81,858	1,329,915	45 19
Northwest	36,907	74,060	69 64	2,494,900	64,616	13,008,323	15,869,579	74 66
Pan American								
Alaska		28,166	67 04	125,445		1,237,242	4,273,671	56 60
Atlantic	326,935	428,750	68 86	2,869,237		5,869,818	53,171,726	62 89
Pacific	87,212	253,228	77 95	2,974,563		3,838,038	32,885,110	72 73
Latin America	339,790	331,012	71 25	992,099		9,345,986	41,270,018	64 15
Panagra	37,328	44,207	61 69	162,319		904,487	5,777,685	59 12
Trans World	92,668	246,223	68 10	2,130,785		2,386,775	30,074,700	71 07
United	32,740	81,337	78 95	270,852		172,829	8,746,387	72 35
LOCAL SERVICE								
Allegheny	115,960	19,257	43 41	20,398	55,182	25,865	1,939,627	45 79
Bonanza	32,517	7,139	43 18	10,768	6,572	23,536	721,997	41 92
Central	32,007	5,304	36 36	11,640	6,295	16,455	541,381	32 36
Frontier	54,489	14,062	51 46	47,867	23,824	177,946	1,667,544	61 90
Lake Central	36,705	5,741	44 10	6,905	40,660		566,895	38 13
Mohawk	94,134	16,545	53 13	16,308	27,102	32,487	1,654,519	50 95
North Central	162,415	26,405	54 69	56,294	95,935		2,678,276	48 78
Ozark	87,257	13,475	37 40	30,851	57,513	31,279	1,379,818	38 64
Piedmont	112,928	21,451	54 67	42,108	42,470	35,902	2,174,093	54 57
Southern	49,196	8,650	43 67	24,984	46,971		900,037	41 94
Southwest	85,997	17,328	53 31	23,642	14,515	23,170	1,710,917	51 37
Trans Texas	59,190	13,487	39 22	39,746	25,970	66,531	1,419,874	36 12
West Coast	62,082	10,792	47 59	10,492	6,744	16,580	1,009,129	47 39
HAWAIIAN								
Hawaiian	134,348	18,679	66 61	10,812		336,017	1,965,684	57 56
Trans Pacific	73,132	9,255	57 67	2,391		52,483	744,056	55 22
CARGO LINES								
Aerovias Sud Americana						1,987,862	1,987,862	71 81
Flying Tiger	19,294	73,516	99 44	99,154	115,817	16,106,353	23,672,691	61 19
Slick	16,043	79,421	94 14	226,893	172,988	13,928,575	22,270,866	77 60
Riddle*								
Seaboard & Western	16,888	76,606	100 60			5,095,204	12,755,869	66 65
HELICOPTER								
New York Airways	11,891	223	57 33	2,795	3,809	1,783	29,058	61 76
Los Angeles Airways	6,293	234	45 88	11,175	5,327		38,007	51 54
Chicago Helicopter Airways				7,632			7,632	41 92
ALASKA								
Alaska Airlines	20,237	5,548	52 05	88,402		885,200	1,594,845	55 23
Alaska Coast	18,673	1,703	66 03	11,698		15,132	199,934	66 15
Cordova	6,563	1,116	60 13	11,041		775,792	900,565	52 15
Ellis Air Lines	24,357	1,257	55 37	6,795		9,540	143,467	63 13
Northern Consolidated	8,495	2,728	53 55	65,611	880	997,580	1,364,194	81 03
Pacific Northern	42,157	33,782	61 06	228,628		1,038,818	4,909,521	68 13
Reeve Aleutian	2,819	1,569	67 95	41,958		154,874	365,751	73 38
Wien Alaska	9,473	3,720	47 81	96,337		181,331	663,437	70 02

* Not available

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board

BETTER TIRES FOR BOMBERS



STRATOFORTRESS—BOEING B-52

BETTER TIRES FOR YOU!

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And the experience gained in building more dependable military aircraft tires has been of very direct benefit to U. S. Royal Tires used by commercial and civilian aircraft.

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United States Rubber

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LOCKHEED C-130A is framed in the rear cargo door of another Hercules on test flights near the Marietta, Ga plant.

USAF Receives Highly Versatile C-130

By David A Anderton

Marietta, Ga—In the Lockheed C-130A Hercules combat transport Tactical Air Command will be getting an airplane of tremendous versatility

The C-130 can deliver men, material and supplies by air drop or landings It is self-sufficient on the ground with starting and other support systems integrated into the airplane itself

Large Payload

The airplane can take off at its maximum gross weight of 124,200 lb in about 2,000 ft and climb out at almost 2,400 fpm It can cute almost 40,000 lb of payload out to an airhead 1 700 mi away off load and return without refueling Under maximum landing weight conditions of 110,000 lb, it can come to a complete stop in about 1,000 ft using maximum reverse thrust for landing

First deliveries of the Lockheed C-130 will be made to TAC's 463rd Troop Carrier Wing next week A flight of the turboprop transports will make the trip from the Dobbins AFB at Marietta to Ardmore AFB Okla Over the Ardmore area, the C 130s will demonstrate the aerial delivery system that is the heart of the big load carrier

Two design factors are responsible for the C 130 performance the efficient lightweight structure which produces an operating weight empty of about half the gross weight and the efficient lightweight Allison T56 A-1 turboprop powerplants, rated at 3 750 eshp each for takeoff

Around these two features Lockheed engineers, first at the California Division in Burbank and later at the Georgia Division here, have developed a conventional airplane with its design refined to do an unconventional job

Description

The C 130A Hercules is a high wing monoplane with four turboprop engines The undersurface of the fuselage sweeps sharply up toward the high tail Under the tail, the fuselage divides on a horizontal line into a door and a ramp

The ramp can be positioned at truck-bed height for ground loading, or dropped for a driveway into the cavernous cargo compartment

On the port side of the fuselage forward of the wing is a huge cargo door Aft of the wing is a pair of paratroop jump doors one on each side Just ahead of each door is a deflector that extends into the slipstream and shields the jumper until he is well clear of the airplane

The whole airplane has a rugged appearance, it looks like the kind of airplane that could take a beating on the ground and in the air and still deliver its goods

Normal crew for the airplane is four pilot co-pilot, systems manager (who is flight engineer and a few other things) and a navigator

The flight deck is enormous; a roomier one would be hard to find The cargo hold is spacious, broken only by the intrusion of the two vertical bulkheads that form the wheel-well and the festooned cables and lines led through the rings and bulkhead frames overhead

Design Changes

Two minor modifications distinguish the current production Hercules from the prototype A larger radome—the Pinocchio nose—houses an AN/APN 59 radar for better identification of the drop zone The vertical tail outline, once gracefully rounded at the tip, has been squared off to mount a rotating red anti-collision light

One major modification has brought an element of suspense to the C-130A program the change from a Curtiss Turbolectric to an Aeroproducts propeller

Some troubles experienced with the Aeroproducts prop have been reflected in delay of deliveries of the Hercules to TAC But, as the Lockheed engineer said, "There's never been a new prop-engine combination that worked right from the start These

C-130A nose houses AN/APN-59 radar for drop-zone identification

BANKING AWAY, C 130A shows bulges for landing gear

CAVERNOUS rear loading door is at truck-bed height

HIGH ASPECT ratio of C 130A wing is performance asset.

kind of teething troubles are normal"

Decision to change propellers was made early this year by the Air Force. As might have been predicted, the troubles with the Curtiss propeller almost ceased after the change was made but by then the procurement machinery had switched to Aeroproducts.

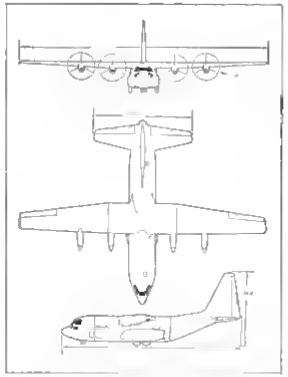
The early difficulties with the Aeroproducts unit have been straightened out and nobody anticipates any further delays in deliveries.

Unusual in Detail

The C-130 is a usual kind of airplane viewed in small but when you study the pieces and the system installations it becomes an unusual one. It is not unusual in the peculiar sense either, but unusual in the engineering sense. On the C-130, everything is functional, designed to the limits, stripped and simplified and made from the highest strength materials.

Examples of these highly functional features:

- **The fuel and electrical power system** control panels. From the usual welter of switches, circuit breakers, dials and knobs, Lockheed engineers evolved simple flow-diagram panels. They combined the simplicity of a schematic diagram with all the necessary controls, monitoring instruments and lights. The result: instantaneous determination of the condition of the system.
- **The landing gear**, with tandem main wheels and a dual nose gear. The main gear is moved by a jack screw system and retracts vertically into the wheel wells. Tires are big and soft; they'll land the Hercules in soft sand or unprepared strips and takeoff from ground soft enough to be furrowed almost hub-deep by the tires.
- **The auxiliary power system**, a gas turbine compressor unit built into the left wheel well, is an air supply unit for engine starts. No ground starter is needed; the plane is self-sufficient at an airhead. One battery is the only susceptible point in the entire system. "Take care of that battery," the crews are told. "Sleep with it if you have to, to keep it warm, because it starts the engine that starts the engines that take you out of the airhead."



Cargo Compartment

"I took off my hat the first time I walked in here," said one visitor inside the C-130 cargo hold. "I thought I was in a cathedral." This is a slight exaggeration; the actual dimensions of the compartment are 41 ft long by 10 ft wide and 9 ft high. The floor is patterned by the 20-in. grid of 10,000-lb. tiedowns. There are 5,000-lb. fittings on walls and ramp. For the big items there are special 25,000-lb. fittings.

The rear door is the size of the fuselage minimum cross section: 10 ft. wide and 9 ft. high. The lower half of the door lowers to truck bed height for transfer of the lighter or palleted loads. Fully dropped, it's a ramp to load wheeled vehicles.

The forward cargo door is 7.3 ft. wide and six ft. high, also at truck bed height.

Two aluminum alloy platforms, one 9 x 24 ft. and the other 9 x 15 ft., are used as part of the aerial delivery system developed by Lockheed for the C-130 and adaptable to other transports. These platforms are loaded with cargo and then rolled into the C-130.

Over the drop zone, the pilot pushes a button for release. An extraction chute deploys and drags out the loads for the drop.

Frank Johnson, manager of Special Projects Engineering, patented a system of outriggers that absorb the landing shock by plastic bending. It keeps the load from toppling over once it hits the ground and absorbs some of the impact shock.

The entire cargo compartment and flight deck is pressurized to maintain an 8,000-ft. level inside at 35,000 ft. outside.

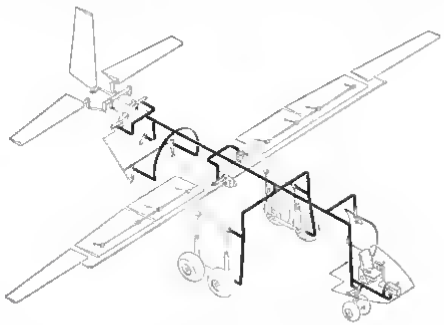
A few steps takes you up to the flight deck, open and roomy and looking very uncluttered. Standardized seating and instrumentation layouts have been used with functional knobs for the operational controls on flaps, landing gear and trim.

The windshields are NFSA glass with the exception of a couple of the curved panels used to view the drop zone.

Hercules' Wet Wing

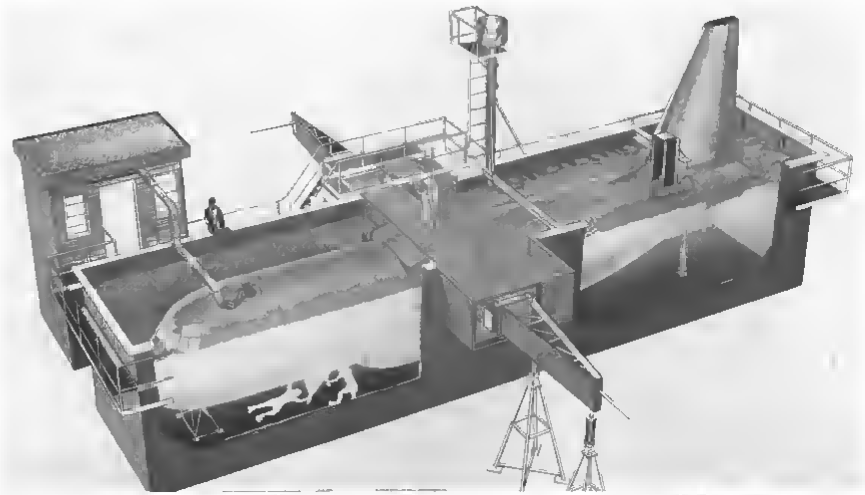
The wing of the C-130 has the graceful lines of a high performance surface. It has an aspect ratio of 10 and a span of 132.6 ft., only a few feet short of the span of a Boeing KC-97.

The wing is a wet wing. 5,080 gallons of fuel is carried in four internal tanks. For combat operations the wing can be fitted with external pylon tanks, pro



HERCULES has three hydraulic systems: utility, booster, emergency.

AVIONIC aids are operated by the navigator in flight deck.



TANK TEST of complete C-130A fuselage is done to check fatigue strength under cycled air and pressurization loadings

tected by self-sealing blankets and explosion-suppression. They are not used to carry extra fuel, but to carry all the fuel at the time the airplane is over a combat area. Fuel scheduling for a mission is planned to empty the wing tanks by consumption and by transfer to the pylon tanks.

The wing structure is a box spar with upper and lower chords formed from integrally stiffened skins. End ribs are built up with vertical stiffeners. Internal ribs inboard are truss work, outboard they are formed metal sections.

Fueling is single point, and access is at ground level near the main wheel well. A fuel control panel is there also for convenience. The tanks can be filled in nine minutes.

Some Systems

There are three hydraulic systems on the Hercules: utility, booster and emergency. Normal pressure is 3,000 psi, provided by engine-driven pumps for both utility and booster systems. The emergency system is pressurized by a pump driven by the air turbine.

The utility system drives the aileron, rudder and elevator boosts, flap, main and nose gear actuators, nose gear steering system and works the brakes. The booster system is only for control boost. The emergency system extends flaps, main and nose gear, operates the wheel brakes and lowers the landing ramp.

The navigator's position is loaded with avionic gear. He has APN-59 radar, ARC-34 and -49 UHF and VHF command radios, APX 25 IFF radio, APN 22 radio altimeter, ARN-6 radio compass, ARN-14 omni receiver, ARN-18 glide path receiver, ARN-12 marker beacon receiver, SCR 718C radar altimeter, CR-3 emergency transmitter, ARA-26 emergency keyer, AIC-10 interphone, Bendix MI-36M public address system, Collins 618S-1 liaison communication system and APN-70 Loran navigational system.

Missions Defined

The Hercules is designed to do four basic missions: airhead, resupply, cargo and logistical support. Each of these requires a different flight plan.

COMPOSITE of pilot positions shows the accessibility of C-130 flight controls

The airhead mission visualizes the C-130 taking off with a 25,000 lb. payload and cruising out to the edge of enemy territory at the altitude for best range. At the edge of the combat zone, the pilot drops to 1,000 ft. and makes a high-speed run in to the landing area. He lands, unloads cargo and takes off without refueling. In this mission, he can operate up to a combat radius of 1,100 nautical miles.

The resupply mission takes a 37,800 lb. payload maximum out to a combat radius of 950 nm. If a lesser payload of 25,800 lb. is used, the combat radius is increased to 1,300 nm. Refueling is not used.

The cargo mission assumes a 25,800 lb. payload and carries it out a distance of 2,520 nm. to the landing area.

Refueling is done upon landing. For the heavy payload of 37,800 lb., the range becomes 1,500 nautical miles.

Last mission is the logistical support, or all-out system. The tactical equipment is pulled out of the airplane and the flight load factor is dropped to 2.5. With that payload, the range of the C-130 becomes 1,700 nm.

Structures

The C-130 had to be designed for high structural efficiency in order to give the weight-carrying capability required by the Air Force. Weight was at a premium and was the major reason for the extensive use of high

Lockheed C-130 A Hercules

WEIGHTS

Maximum Takeoff Gross Weight, lb	124,200
Takeoff Weight for Limit Flight Load Factor of 3.0, lb	120,100
Landing Weight for Sinking Speed 5 fps, lb	110,000
Landing Weight for Sinking Speed of 9 fps, lb	96,000
Operating Weight Empty, Airhead Mission, lb	63,800
Operating Weight Empty, Resupply Mission, lb	61,300
Operating Weight Empty, Cargo Mission, lb	61,300
Operating Weight Empty, Logistical Mission, lb	59,800

DIMENSIONS

Wingspan, ft	132.6
Overall Length, ft	97.7
Maximum Height, Three-Point	38.0
Wing Area, sq. ft	1,745.0
Cargo Compartment Length, ft	41.5
Compartment Width, Minimum, ft	10.3
Compartment Height, Minimum, ft	9.1
Ramp Length, ft	9.4
Useful Cargo Volume, Including Over Ramp, cu. ft	4,300.0
Cargo Volume, 100-in. Loading Height, two 18-in. Aisles, cu. ft	3,680.0

strength aluminum and steel alloys.

Design was to zero margins, with probability values used rather than guaranteed. This further reduced the weight by eliminating unnecessary structural weight and volume.

The C-130 was designed to limit load factors of plus three and minus one. The structural guts of the airplane is a solid framework at the connection between wing center section and fuselage. The wing box spar is riveted to the vertical web bulkheads that are the inside faces of the wheel wells. Floor members connect the bottom of the framework to complete the structure. All the rest of the airplane hangs on this unit.

Tail Strength

Design criteria for the vertical tail originally specified a side load of 24,000 lb., but the structures people took a second look. It was possible to visualize a situation of complete failure of engine fuel flow on one side, coupled with a failure of the negative torque signal system (NTS) that normally decouples the prop instantaneously upon any failure that would convert the prop from the thrust producer to an energy absorber.

In this special case, the unsymmetrical force on the airplane due to the instantaneous dead engine produces a tremendous yawing moment and adds a large increment of load to the vertical tail.

For that reason, the vertical tail and aft fuselage have been redesigned beginning with the eighth airplane. The change will be retrofitted in modifications of the first eight, although it will not be made on the two YC-130s.

As redesigned, the tail will take a side load of 40,000 lb. which is the load that would be applied at the critical flight speed of 183 knots if there were simultaneous failure of fuel flow and NTS. The critical speed ties in to the placard flap speed for the flaps when the props are in the beta range of pitch angle. This condition would produce the most critical unsymmetrical loading.

Cargo Doors

Another tricky design problem was the rear ramp-door combination. The criteria were fixed by pressurization loads not by the static weight of the cargo that would be rolled up the ramp into the fuselage. The pressurizing load is about 15 psi, twice the normal maximum of 7.5 psi differential; maximum cargo loading works out to less than half that, actually less than 7 psi.

With the door and ramp open, the structural strength of the airplane is obviously reduced. Limit speed under those conditions is 150 kts. The original design provided for a speed of 130 kts., but the structure proved capable of taking the extra margin of speed.

Critical wing condition for the inboard section occurs when the plane has reserve fuel loading in the wing at 98,000 lb. gross weight with a gust load factor of 3.4 applied. Originally, the aileron roll condition was the critical criterion for the outer panel design.

Pressure Testing

Skin divers and underwater television have been contributing to the C-130 program. The divers and TV have been used to monitor from underwater in the pressure-fatigue test tank, the condition of the outer surface of the C-130.

A 260,000 gallon tank was completed

earlier this year and is being used to check the fatigue strength under pressure. So far the complete fuselage has been subjected to the equivalent of about 10,000 flight hours—3,220 test cycles in the tank—at the full pressure differential of 7.5 psi.

Analysis of the flight loads on the pressurized airplane showed that side gust loads and landing loads had negligible effect on the fuselage compared with other loadings. Further, fatigue load damage due to cycle loading was found to be quite small compared with the damage done during a mean flight load combined with pressure.

Loads encountered during a typical three-hour flight from takeoff to landing could be conservatively simulated by a single 1.72 G flight load with cabin pressure superimposed. This was the test condition.

Manufacturing

Components for production of the C-130 are built at widely-scattered points on the floor of Government Aircraft Plant 6. The order of the system is nowhere apparent until the final stations of the assembly line. One of the prime reasons for this is that the whole line is being rearranged to phase C-130s into a double-ended line after the phase-out of the last B-47 construction this month.

But another prime reason is the flexibility of the huge plant. With crane service feeding any portion of the plant floor area and a moderate production rate, there is no need to build the high-density production areas with mobile lines that characterize the production of Convair's F-102A (AW June 11, p. 50).

The C-130 is a low-density airplane: it has a large wingspan and a long fuselage and a high tail. It is not closely packed like Lockheed's supersonic Starfighter, the F-104A. It takes elbow room to work around it.

Hercules' Skeleton

Basic C-130 structure is conventional but built by a number of what have been unconventional production techniques: integrally stiffened skins; metal bonded assemblies; large forgings; high-strength steel and aluminum alloy parts; titanium components.

The integrally stiffened components were designed that way probably the first case where that technique was specified in the layout stage. Some integrally stiffened panels have been adopted into the Lockheed Constellation series, but these were essentially engineering changes made later in the production development.

The wing center section uses "net" extrusions, which need only a single flat cut on each surface and one on each end. On the wing outer panels, "gross" extrusions are used, which require finish machining all over.

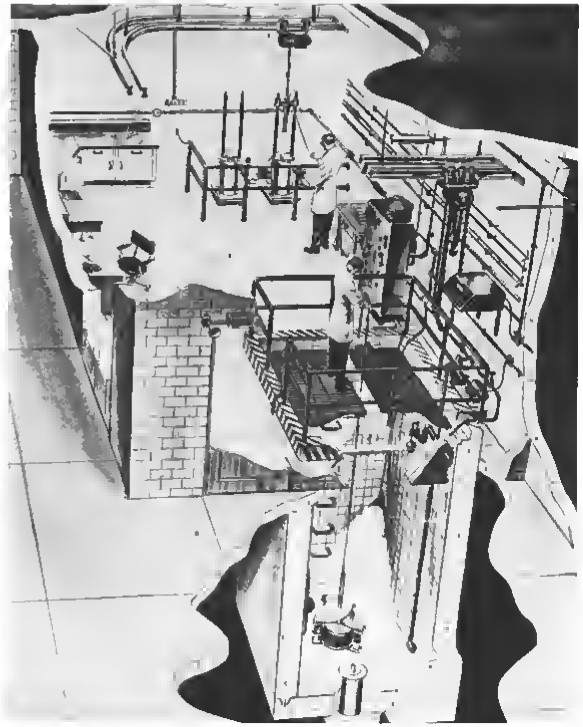
"Net" extrusions cost somewhat more per pound, although the overall net cost is lower because of some reduction in machine time and the great reduction in the amount of chips produced.

Georgia Division has four giant Kearney & Trecker skin mills, two of which belong to the Air Force and two to Lockheed. The Lockheed units, built a little later than the USAF mills, are somewhat more advanced in capability. They cost about a quarter of a million dollars apiece.

Lockheed production engineers have developed several techniques for the hot-forming of parts using electric resistance and inductance heating equipment.

Titanium parts are formed on plastic-surfaced tools, the sheet is gripped by electrodes while suspended above the tool, and the hammer strikes it down on the tool in a short time cycle which does not damage the plastic surface.

Plastic dies are used also in the hot-forming of the magnesium parts on the C-130. The sheet is brought to forming temperature by heat applied through the jaws. Hot dies have not



Radiatian Source

A source of gamma radiation, a tile lined pool of clear blue green water 6x6 ft. and 12 ft. deep, is a new facility at the Nuclear Division, Glenn L. Martin Co., Baltimore. The Martin Gamma Facility (MGF) primarily will be used to test the effect of radiation on various materials, and also as a prime research tool for background information. The 5,500 curie, cobalt 60 gamma radiation source has a stainless steel disc, 2 ft. in diameter, centered in the bottom of the pool. Equally spaced around the perimeter are 78 pencils of cobalt each extending 13 in. up from the disc. These account for 4,000 curies. An aluminum clad cobalt cylinder, 2½ in. in diameter, extends 13 in. up from the center and accounts for another 1,500 curies. Martin says the facility will considerably widen the scope of radiation work. One of the goals is to find an organic moderator for the Martin reactors.

been used, nor has it been necessary to heat the blanks in an oven.

Some jogging operations require a heated die, but these are kept to a minimum.

Metal bonded assemblies, which make up such structure as the wing trailing-edge sections, are fabricated in the conventional manner. Lockheed uses about 100 such assemblies in the C-130 buildup.

High strength 4340 steels heat-treated as high as 280,000 psi., are used in a number of spots to reduce weight of parts and provide extra volume.

Large quantities of A78ST alloy—a high strength aluminum alloy about 7% stronger than 75ST—have been used in the C-130, mostly in extrusion and plate form.

Unusual Items

Some aspects of the Hercules design posed unusual problems from a manufacturing point of view. The large fuselage of the plane, pressurized to a high differential, and containing a number of doors, produced a problem of pressure testing. The fuselage line has a station surrounded by canvas walls and roofed with wire mesh, where on-line pressure testing of the fuselage is done to check the integrity of the complete fuselage. Only the forward portion has been pressure tested up to that station on the line. There have been a couple of minor ruptures in the tests of the fuselages built so far, but nothing very serious.

A second test area on the fuselage line is a water spray booth, where the assembled fuselage can be checked for leaks under simulated torrential rains.

The paint spray hangar, traditionally located remotely from the factory floor area, is too small to take the complete C-130. In its normal attitude the tail won't clear the roof or the wings won't clear the doors. So the Hercules is dolled sideways through the doors, with its nose in the air and tail down, for painting.

On the line, standard wheel chocks can't be used; the soft, large tires allow the Hercules to walk right over the chocks with engines running. So chocks are built up higher than usual and pinned to the ground for added strength.

Subcontracting

About 35% of the C-130 is subcontracted: tail surfaces, doors, flaps, ailerons, landing gear and power pack are delivered to GAP-6 at Marietta. Rohr Aircraft has an assembly plant at Winder, Ga., for buildup of the complete installation of the Allison T56 in a quick-change unit. Avco Manufacturing at Nashville and Temco at Dallas build components. Menasco

Supersonic Tunnel

Supersonic wind tunnel is one of three new tunnels recently added to the United Aircraft Corporation's Research Department. Others are transonic and supersonic which is capable of simulating speeds up to Mach 10. Flexible top and bottom walls of supersonic tunnel (above) permit rapid changing of tunnel shape to achieve a different Mach number

Manufacturing Co. delivers the unusual landing gears.

Early in the program some of the tooling was built at Lockheed's Burbank, Calif., plant to designs supplied by Georgia Division tool engineers. Quantity of current tooling will allow for a production level a little over that called for on the C-130 schedule, there has been no attempt to tool for a doubling or tripling of the program as has been the case with a few other military aircraft.

Formal requirements for a different kind of combat transport were developed to final form by Tactical Air Command early in 1951. Air Materiel Command sent its requests for bids out to the aircraft industry Feb. 2 that year.

Preliminary Design

The preliminary design office at Burbank went into action and by April had forwarded a few alternate designs to the Air Force. One of these designs was along the pack plane line that Fairchild used in the XC-120: there were a couple variants on the basic upsweptfuselage layout that became the C-130. Other manufacturers submitted proposals also but Lockheed learned in June that their effort won the competition. Two months later work on the prototypes began at Burbank.

That month a crew of eight group engineers was integrated into the preliminary design office at Burbank to follow through on the C-130. By March 1952 a mockup had been built. It was completely functional and mobile. It could be loaded with cargo, its steel floor tested with far more than normal loads. The first YC-130 mockup review was held that month. Lighting mockup and final configuration inspection was in June 1952.

Move to Burbank

In the fall of 1952 project engineer A. D. Brown was assigned to the job and moved temporarily to Burbank from Georgia Division which had earlier been given the production responsibility for the airplane. Brown integrated his systems engineers into the preliminary design group and by January 1953, the production design was far enough along to start moving intact groups back to Georgia. The complete transfer was an easy job, and took from January to June 1953. Forty people had gone out to Burbank, by June they were all back with a couple of exceptions.

Brown closed up the Burbank shop and left for Marietta.

Meantime the engineers had the unique experience of moving their monstrous mockup to Marietta. It had to be transported by sea, lashed to the deck of an Army Engineers' transport. At Savannah, it was off loaded and began its march through Georgia.

School children turned out on a half-day holiday along the route. A corps of telephone linesmen went along to cut and splice lines that were in the way. The draped shape, formless like a dead whale, was trundled to its place in the huge Marietta plant.

In April 1954 there was a development engineering inspection on the YC-130. The big day was August 23 the prototype roared off the runway and climbed out on a 30-degree flight path from Burbank to Edwards AFB.

In October 1954 the Air Force conducted its contractor's technical compliance inspection on the YC-130.

The first production plane took off on April 7, 1955; first deliveries to the USAF begin next week.

'Ski-130' Version

Early next year a special ski-equipped Hercules will be delivered to the Air Force for cold-weather testing. Lockheed's work began about one year ago to a requirement one year older than that.

Primarily the Air Force wanted to investigate the performance of the C-130 in a special version that could some day become a supply transport for Arctic operations such as the Dew Line. Major question to be settled is whether or not skis are actually worthwhile. There is one school of thought that believes skis necessary for operations in soft and deep snow. The other school says that there is so little soft and deep snow in areas that would require air supply that the skis are unnecessary. Many Arctic areas already have their snow and no more falls. What is there as part of the polar ice cap is so wind-eroded and so solidly packed that it acts about like concrete.

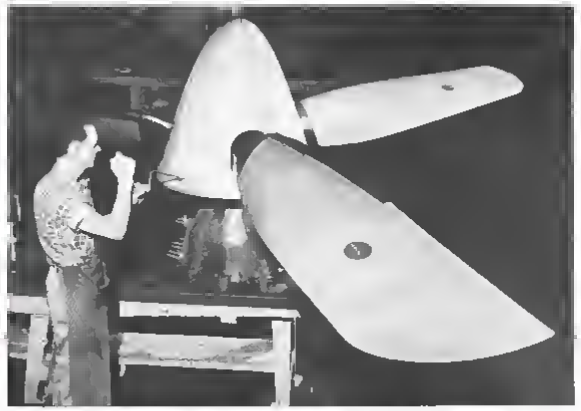
The largest previous ski installations were on Lockheed P2Vs modified for the Navy as Arctic supply ships. The bulk of past operation experience has been with the venerable Douglas C-47.

The skis on the C-130 have a footprint pressure of 564 psf. Each of the main skis is 19 ft. 6 in. long by 66 in. wide; the nose ski is 9 ft. 8 in. long and 65 in. wide. They retract to a nearly flush position and have negligible effect on the aerodynamic performance of the plane.

Ski Design

For the C-130 overload gross weight condition of 124,200 lb., the ski installation costs only 3,000 lb. That means that cargo loads of upwards of 30,000 lb. can be carried in the Ski-130.

One of the reasons for the overall



Propeller for 1649A Constellation

Assembler tightens spinner fasteners for new hollow aluminum blade propeller made by Hamilton Standard Division, United Aircraft Corp., for Lockheed 1649A Constellation. Propeller diameter has been increased from 15 ft. on the 1649G to 16 ft. on the 1649A. Engines have been moved farther out on the 150-ft. wing. Main gear tread has increased from 28 ft. on the 1049G to 38 ft. on the 1649A, and since the gear retracts into the inboard nacelles this approximates the inboard engine spacing.

light weight of the installation is that the skis were designed according to aircraft instead of backwoods experience. Machined cap strips and bottom elements have been used.

Aluminum gages for the skis were chosen on a unique basis. The designers assumed that the plane would be frozen to the ice and have to be dug out by a bunch of heavy-handed airmen equipped with picks. For that reason the bottom plate is ¼ in. thick.

The ski installations are attached to the main landing gear as in conventional practice. Loads applied during ski landings are transferred to the landing gear through the axles. There is auxiliary springing applied through knee action linkages to compensate for the amount of energy normally absorbed by the tires.

Ski Versatility

The bottom of the ski is covered with a layer of Teflon plastic over the plating to minimize friction in deep, wet snow. The bottom of the C-130 is covered with fiberglass panels covered with Teflon in order to protect the belly structure against ice impingement.

The nose ski is steerable through 60 degrees and is hydraulically rigged to hold the horizontal attitude either down or retracted. There are centering air springs for traversing rough terrain.

Actually the snow ski is a lot more versatile than most people believe. Bush pilots have been making water landings with them for years, they also permit landing in mud and marshes and on turf. But these extras are not intended as routine for the Ski-130.

Its primary purpose is to land on snow—the soft, deep, sticky kind or the hard-packed, wind-eroded sastrugi ice of the polar cap.

These skis are designed to be retrofitted, should the Air Force decide to order a batch of C-130s so equipped. They could be shipped as a kit for depot retrofitting and provisions for the installation could be serialized on the assembly line. The skis themselves, their mechanical elements and fairings could be a field kit.

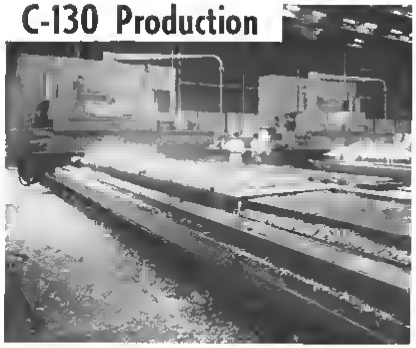
First KC-135 Will Be Delivered in Spring

Seattle—First Boeing produced KC-135 jet aerial tanker will be delivered to Strategic Air Command's B-52 base at Castle Air Force Base, California, in the spring of 1957.

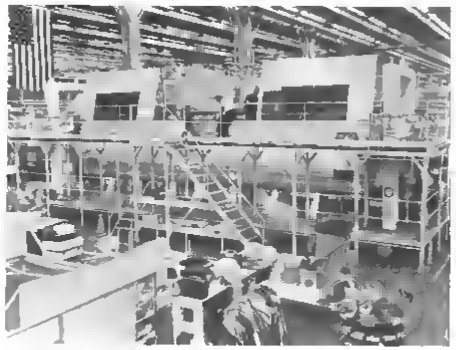
Greater speeds, 600 mph. plus, and higher altitude performance of KC-135 will eliminate the need for high performance bombers to descend to lower altitude to refuel, which is now true of prop-driven KC-97.

Brig. Gen. William E. Eubank, Jr., commands 93rd Bomb Wing which is now organizing a training cadre for checkout of training crews for KC-135. Castle will be the training center for all SAC units under present plans.

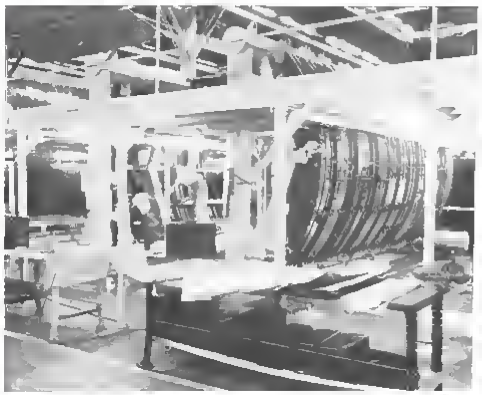
C-130 Production



SKIN MILLS make C-130 wing center section, outer panels

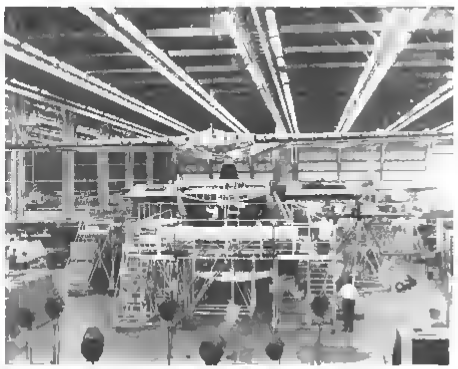


CENTER SECTION in jig is fabricated from box beam, trailing edges.

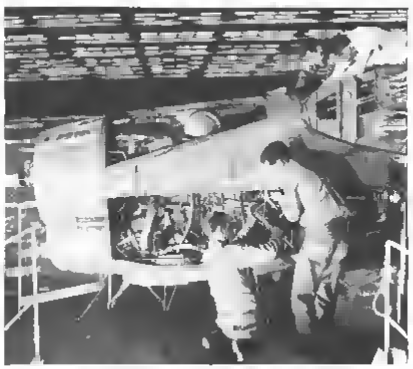


FIRST ASSEMBLY joins wing center section and fuselage barrel in jig.

FUSELAGE BARREL is traditional shell structure.



HORIZONTAL TAIL is fitted on final assembly to elliptical bulkhead



POWER PACKAGE on final assembly, is built by Rohr Aircraft.

OUTER PANELS contain integral fuel tanks, dry bays around Allison T56 powerplants.

COMPLETED FUSELAGE is crane-transported from its line to position on final assembly.

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GE Develops New Turbine Wheel

Lynn, Mass.—General Electric Company's Aircraft Accessory Dept. has developed a new aircraft hydraulic turbopump, feature of which is a redesign of the turbine wheel.

GE says the new design adds another protection against turbine wheel overspeeding with new light weight buckets which fly off harmlessly when a point above normal speed is reached.

Last February after a Boeing B-52 crashed, a USAF crash report said a turbine wheel overspeeded and disintegrated. Fragments of the wheel blasted through one of the plane's fuel tanks.

The turbine powered by the B-52's low pressure pneumatic system, drove one of the system's alternators. However, the turbine wheel was not a GE product.

The tiny buckets on the new GE wheel, each weighing only .03 ounces, are fastened to the turbine disk by a single shear pin. If an overspeed condition occurs because of a failure in the turbine wheel governor or of the overspeed control, the pin breaks and the bucket is contained with the turbine wheel housing, thus slowing the wheel.

The new turbopump which the wheel drives called the Model AP-15, generates hydraulic power to actuate landing gear, bomb bay doors, control surfaces and other components. Gear box is eliminated in the new turbopump, enabling power to be transmitted directly to a high speed, ball piston type pump which produces 8 gpm of hydraulic fluid at a pressure of 3,000 lb. per square inch.

The GE Aircraft Accessory Turbine Dept. produces turbine driven equipment for the Boeing B-52, the North American F-86D and the Martin B-57.

West Coast Center For Research Opened

Pasadena, Calif.—Consolidated Electrodynamics last week formally opened its $1.5 million 130,000 sq. ft. Engineering and Research Center here. Further expansion is planned for early next year when the company will begin construction on two additional 130,000 sq. ft. buildings on the Monrovia, Calif. airport.

One of Consolidated's largest projects is providing electronic instrumentation for the 5,000 mi. test range from Patrick Air Force Base to Ascension Island, a range that will be used to test the Air Force's intercontinental ballistic missiles.

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AIR-TURBINE DRIVES . . .

The Answer to Jet Age Accessory Power Problems

The need for hydraulic, electric, and mechanical power multiplies with every major advance in aircraft performance. The high air speeds of today's jets demand more hydraulic power for aerodynamic surface and braking control. Widespread use of electronic equipment has greatly increased electrical requirements. The blistering surface heat of high-performance planes only compounds the problem. Not only must today's designer plan an accessory system that can meet increased power requirements, in much less space, but he must be sure it can operate in hot environments.

Some accessory equipment now in use is grossly affected by heat. Direct drives attached to the engine, hydraulic motor drives, and gas turbine power units (GTPU's)—are extremely vulnerable to high ambient temperatures. In addition, they generate so much heat in operation that a method of removing the heat must be employed. Other limitations such as inadequate lubricants, heat pumps or the absence of extremely high temperature metals may preclude the use of these methods if thermodynamic requirements continue to grow.

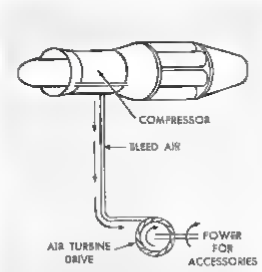
Heat Problem Changes The Design Picture

The heat problem has become so complex that top engineers now realize the importance of integrating the accessory system as part of the basic powerplant and airframe design effort. In the absence of adequate alloys to withstand high skin temperatures, designers now see the advantage of installing thermal-conditioning equipment and airducts as part of the airframe design in order to cool surface areas as well as internal components.

As a reliable, convenient source of compressed air, the jet engine provides the way to solve many of these problems. Air, extracted from its compressor, can be ducted to nearly any part of the aircraft surface for purposes of cooling, boundary-layer control, and deicing. Since the weight of this equipment is chargeable to the aircraft mission, it becomes practical to use the common energy source—compressed air—for operation of the plane's entire accessory system.

Air-turbine Drives Permit Integrated System

This trend casts new importance on the role and selection of accessory systems. With a compressed air supply already integral with the airframe, the use of air turbine drives permits more effective integration of the airframe and the accessory system. In many installations, the same air used in the existing airduct system can be used to spin small turbine wheels mounted on shafts. These, in turn, drive generators, hydraulic pumps, fuel pumps, thermal conditioning equipment, mechanical actuators, and other accessories.



Turbines Run on Air Ducted from Compressor

Operating on this simple principle, air-turbine drives can effectively perform nearly every accessory function aboard jet or turboprop aircraft.

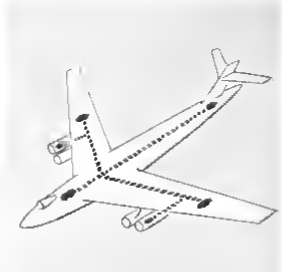
Simpler Construction— Greater Reliability

Air turbine drives are inherently more reliable because they require fewer moving parts than any other method of generating power. Only one efficient rotating turbine wheel and shaft is required to drive the plane's electrical and hydraulic units. Completely automatic operation is obtained by an integral control system. Whenever a load demand occurs, a system of signaling and actuating devices changes the unit's output to meet the power requirements.

Reliability of an air turbine drive system is achieved by cross-manifolding the plane's air supply ducts. Through this method all units on the aircraft can operate from one or any combination of engines. In multi-engine aircraft, failure of one or more engines would not mean loss of accessory power as long as one engine remained to supply bleed air.

The operating history of units now in use, such as those on Boeing's B-52, shows that the simple, comparatively friction-free construction of air turbine drives can greatly minimize wear and result in longer, more dependable service. In addition, they permit more effective paralleling of generators if required, and with a ground source of air can be tested without running the main engines.

Install Where Power Is Needed



Air-turbines Permit Functional Location

Air turbine drives and the accessories they operate may be located anywhere in the plane where power is needed. In the B-52, for example, ten hydraulic turbo pumps are distributed in both wings and the fuselage—close to the point where power is needed. Such versatile functional location is possible because air is relatively easy to transport and because it requires no return system.

Located away from the engine, these drives can contribute to a sleeker airframe design by cutting engine nacelle size and reducing frontal areas. Also by installing them close to the "service area," short hydraulic and electric transmission lines can be used. This results in a lighter and less complex system.

These advantages permit a significant increase in aircraft speed and range, or payload.

Forecast for the Future

Ramjet and Nuclear Powerplants—It is expected that air-turbine drives will play an increasingly important role in the future. In aircraft utilizing a turbo ramjet, the turbojet portion of the engine may be shut down during the supersonic portion of flight. This would mean that no mechanical power would be available from the main powerplants for accessory operation. A pneumatic system, however, could provide accessory power under such conditions.

Another indication that more accessory power will be needed in the future exists in the anticipated requirements for nuclear powered aircraft. Large amounts of power may be needed for specialized functions associated with the reactor. Remotely located air turbine drives, linked with an auxiliary power unit, could supply a huge block of power without a prohibitive increase in unit weight or size.

G.E. Pioneered Air-turbine Drives

General Electric's Aircraft Accessory Turbine Department in Lynn, Mass. is one of the nation's prime suppliers of air-turbine drives for aircraft accessory power.

Drawing on G.E.'s vast experience in producing industrial and aircraft gas turbines, this department has consistently advanced the state of turbomotive equipment design.

Just as General Electric pioneered the "radical" aircraft turbosupercharger in 1918, through the Aircraft Accessory Turbine Department it is now building air-turbine drive equipment to answer the accessory power problems of the jet age.

G-E Turbopumps and Turbodrives help supply all hydraulic and electric power on the Boeing B-52 Stratofortress, first aircraft in history to use pneumatic-driven power equipment for operating its entire accessory system.

Driven by air ducted from the jet engines, G-E turbopumps and alternator drives supply 8 gpm at 2650 psi and 60 kva at 400 cps, respectively. They give the big bomber power for operating steering control surfaces, landing gear, bomb-bays, spoilers, radar, lighting, and armament.

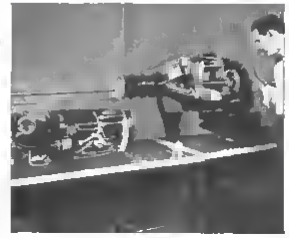
G-E Fuel Turbopump

This tank-mounted air-driven unit provides 86 gallons of vapor-free fuel per minute, giving North American's F-86D interceptor the extra fuel needed for afterburner operation. Characteristic of G-E air turbine drives, the Afterburner Fuel Pump is lightweight and compact and can be functionally located in the aircraft.

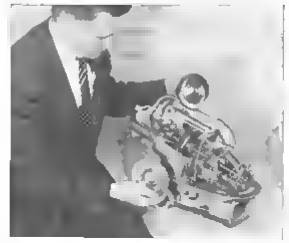
G-E Turbostarters

Another application of the versatile turbine is in the self-contained turbostarter (used on the Martin B-57) which starts a jet engine in less than 10 seconds.

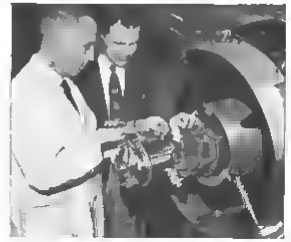
It is powered by hot gases resulting from the combustion of an easily replaceable solid propellant cartridge. Turbostarters eliminate the need for ground power starting units, minimize logistics problems, and increase jet aircraft availability.



G-E Turbopumps and Turbodrives Help Power B-52's Accessory System



G-E Afterburner Turbopump Gives North American F-86D Instant Power Reserve



G-E Turbostarter Gives Martin B-57 Quick Starts. G.E. Also Makes Fuel/Air Starters

Advanced Air-turbine Drives Are "In the Works"

General Electric's Aircraft Accessory Turbine Department with facilities valued at more than $15 million is carrying out an extensive development program on advanced air turbine equipment. Units with extremely high power-to-weight ratios are already in advanced stages of testing. These programs promise powerful answers to accessory power requirements that lie ahead.

To find out how G-E air turbine equipment can help you now in the planning stages, contact your General Electric Aviation & Defense Industries Sales Office or write for the descriptive brochures on the drives you are interested in.

General Electric Co., Section C231-6,
Schenectady 5, N. Y.

Please send me the following brochures on G-E Air-turbine Drives

- ☐ GEA-5870A Air-turbine Drives For Jet Aircraft
- ☐ GEA-6333 Hydraulic Turbopumps For Modern Aircraft
- ☐ GEA-1088 Gas Turbine Starters For Jet Aircraft
- ☐ GEA-5871A Aircraft Afterburner Fuel Pumps

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GENERAL ELECTRIC

Closer Liaison Urged Between Tool And Airframe Industries

By Irving Stone

Los Angeles—Closer liaison between the machine tool and airframe industries is necessary to speed solutions to difficult production problems new aircraft designs will bring J. H. Famme, assistant chief engineer, Convair (San Diego) Division of General Dynamics Corp., stressed this proposition before production, tooling and design engineers attending the Second Annual Contour Machining Conference sponsored by True-Trace Corp., El Monte, Calif.

Emphasizing that thinking on both sides must be long range, Famme pointed out that there is a four-year lead time from the design of a machine tool to the training of an operator to run it.

To a large extent, what Convair has in the F-102 in the way of materials and machining methods will be present in the F-106 interceptor and even in the 880, the medium range jet transport the company plans to have in production by 1960, Famme said. The situation boils down to this:

"Materials and machining will be virtually unchanged for the 880 jet transport because there is no alternative—because the machine tooler's lead time is as long as the aircrafter's.

"But when we reach the stage of building airplanes for Mach 3 and 4 speeds, there will be drastic changes. New materials will be necessary, and with them, new tooling methods. The machine tool builders need to be planning now for that time."

Machining Tolerances

A common complaint from shop personnel is the ever-increasing close machining tolerances required by engineering. Famme declared. Machine tolerances are relatively easy to hold on most operations to ± .010 in. From a weight standpoint, such a tolerance is unsatisfactory, he said. A machine operator likes to work on the high side of the specified tolerance. Hence, most machined parts tend to be on the plus side of the calculated weight, which is based on the nominal dimension.

Closer tolerances will be specified in the future, Famme said. This means a greater machining problem. More and heavier equipment will be neces-

Orpheus in Ashton Test Bed

Bristol Orpheus turbojet engine, which has completed more than 5,000 hr. running and is now developing 4,500 lb. thrust, is installed in an Avro Ashton test bed for flight development. Light weight engine is specified for Breguet Taon, Dassault Etendard VI, Aerfer Arete, Icarus @ 12, Hispano H.A. 300 and the Fuji F.I.T.-1. It has flown in Folland Gnat.

sary if machining is to continue in the same manner.

Closer tolerances result in less weight, which means increased performance. As an example, Famme pointed out that a long-range bomber requires 0.8 lb fuel for each pound of aircraft weight. If a pound of weight is saved, not only is the speed increased, but the range is increased and there is a better chance of completing the mission. An interceptor can obtain an additional foot of altitude with each pound of weight saved.

Famme gave these figures: Each additional .001 in. per square ft adds 0.144 lb for aluminum alloys and 0.413 lb for steel.

Considering 100 sq. ft. of surface, this amounts to 1.44 lb. and 4.13 lb., respectively.

For a supersonic fighter with aluminum alloy skin and a wing area of 700 sq. ft. (upper and lower surfaces totaling 1,400 sq. ft.), the possible tolerance overweight penalty would be: — .000 + .010 in., 202 lb.; + .020 in., 404 lb., + .030 in., 606 lb., + .040 in., 808 lb.

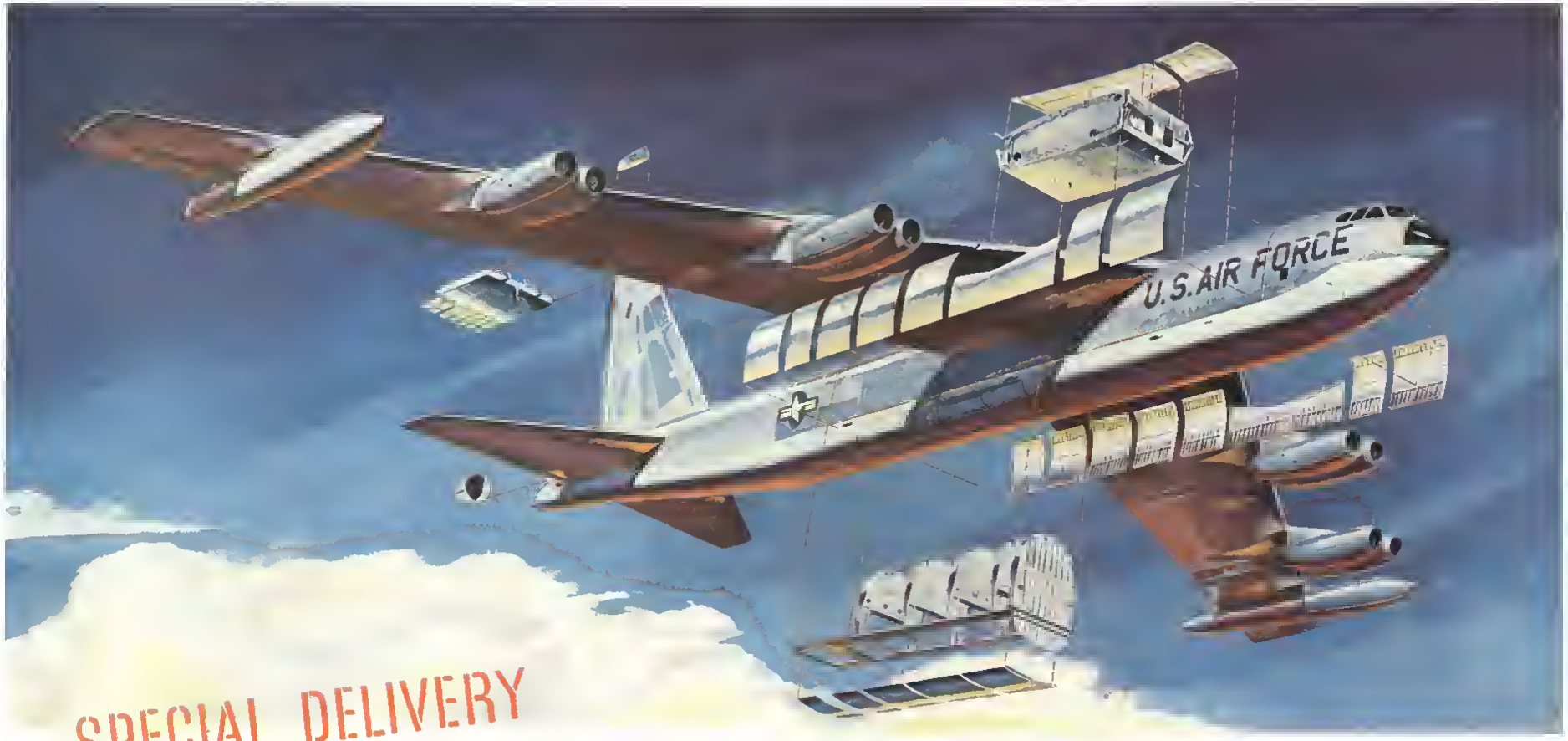
This does not consider the milled areas of forgings and attachment fittings.

Alloy Steel

When aircraft for speeds of Mach 3 to 4 are built, alloy steel will be used, Famme points out. For the same fighter with a wing area of 700 sq. ft. with steel alloy skin instead of aluminum, the corresponding tolerance overweight penalties possible from nominal thickness would be 578 lb., 1,156 lb., 1,734 lb., and 2,312 lb., respectively. In a bomber, with perhaps a wing area of 2,000 sq. ft., the weight problem becomes serious with extreme tolerance conditions, Famme said.

Transition from soft materials, such as aluminum, to hard metals, such as steel, for aircraft and missile construction has already begun and is progressing at an accelerated rate, according to a report of the Air Research and Development Command, Famme declares. The report, he said, points out that based on the same volume of material removed by machines, production utilizing the new hard materials will involve a 400% increase in machine tools, power and labor. Development of production techniques has not kept pace with weapon development, and few of the specialized tools required for this changing state of the art are in industry's hands, Famme said.

"It is feared that the plastic forming of materials to minimize the need for stock removal presents so many problems and complexities that no real solution can be obtained in time. Therefore, simultaneous coordinated effort must be placed on research and development. We need new methods of ma-



SPECIAL DELIVERY TO: BOEING

To help Boeing turn out the nation's largest production jet bomber in record time, Goodyear Aircraft Corporation was asked to gear its big Litchfield Park plant in Arizona to the task and get it humming in a hurry.

Shown are a host of major components—mass produced by Goodyear—now being assembled into the vital American armada of B-52 bombers by the Boeing Airplane Company, builder of these huge 8 jet mainstays of the United States Strategic Air Command.

From the massive stub wing-root sections, center fuselage sections to the exacting structural plastic radome which forms the "stinger" at the plane's tail—Goodyear has delivered these components on time, on specification.

In addition, The Goodyear Tire & Rubber Company provides huge fuel cells and tires for the B-52.

At Goodyear Aircraft's main Akron facility important components are also being built for other aircraft and missiles—encompassing exacting skills in metalworking, structural plastic and electronics—in the service of air power and air progress

These are examples of the manifold ways in which Goodyear Aircraft Corporation serves its dedicated task —that of *Keeping America First in the Air.*

WRITE FOR "Ribbons Of The Valiant"—new full-color booklet which tells the interesting tale of Goodyear Aircraft Corporation in serving American air power. Requests are invited on company or service letterhead. Address Goodyear Aircraft Corporation, Dept. 931AX, Akron 15, Ohio

ON TIME, ON SPECS FROM: **GOODYEAR AIRCRAFT**

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tential forming and removal if the same quantity of dollar value of weapons is to be maintained," Famme declared.

Mechanical Properties

Machine tools of the future must be able to remove material without destroying the mechanical properties of the remaining surface, he said. Physical properties can be restored by treatment but mechanical defects cannot always be restored and, being of an incipient nature, may result in failure.

Famme mentioned chemical milling as having unlimited future, calling this development a challenge to machine tool builders and designers which must be seriously considered. The leading edge of the F-106 requires about 60 min. to etch. Machining the part would require about four hours.

Convair also is investigating the possibility of machining forgings and other parts to an overall dimension somewhat larger than that specified, and then chemically milling all over to the blueprint dimensions. This may eliminate some of the warpage problem, and remove the limitation on minimum web thickness, Famme says.

GE J79 Overhaul Capacity Available

General Electric now has the capacity to overhaul and service all the J79 engines it will sell in the next 5-10 years, according to Everett W. Denison, manager, Manufacturing Engineering, Evendale Operating Dept., Cincinnati, Ohio.

The Evendale overhaul facility now is fully occupied with overhauling the older J47s. However, these will be phased out of USAF in time to free the overhaul facility for the J79. Denison said it is unlikely the military demand for the J79 will take up all the slack to the extent that there won't be room for servicing J79s sold to airlines.

Maintenance on J79

Denison, who spoke before GE's recent Overhaul Symposium, commented on the $71,000 overhaul cost and 2,400 manhours overhaul time chalked against the J79 at the recent Tinker, Okla. AFB symposium (AW Oct. 29, p. 32). Denison said it should be understood these figures applied only to the first three J79s overhauled to date. More experience will cut these amounts to less than one-half, he said. It is unfair to compare the brand new J79 with engines which already have had costs lowered through accumulated experience.

J79 consciously was designed for maintainability, said J. A. Munn, supervisor, of J79 installation engineering. Despite its advanced performance, cer

tain features aimed at expediting maintenance were worked into the design.

The horizontally split casing has been carried practically continuously the length of the rotating parts. This construction has even been extended to the J79's turbine housing. Advantage is that while the efficient structure of the outer monocoque shell is maintained, the various half sections may be removed (like cowling access doors) to have an intimate visual inspection of the outer parts of the rotating members below. As this opens up both sides of the air-fuel flow path through the engine, foreign object damage and extent of overtemperature readily can be assessed.

Accessibility Key

In jets where most of the damage is done either from loose runway matter upon take-off or overtemperature of hot parts due to fuel nozzle misalignment or hot starts, accessibility to the vulnerable parts is the essence of maintainability.

Removing the variable stator actuating linkage rings on the J79 before opening up the forward compressor section only adds another ten minutes, Denison said. In fact he does not see why it should take any longer, if as long, as a similar inspection on a comparable dual spool engine. The variable stator blade angles are set upon original manufacture and should not have to be readjusted upon replacement unless some damage to the external linkage destroyed the original adjustment.

Afterburner spray bar inspections and replacements were simplified, at no cost in weight or performance, by mounting the spray bar on its own frame and sandwiching the assembly between the turbine frame and the afterburner pipe.

Production Problem

Not all features which could have increased maintainability were added. For example, manufacturing the turbine disks so accurately that they could be interchanged without rotor rebalancing would have cut this operation out of maintenance, but the idea was dropped when it was estimated the manufacturing headaches necessary to achieve this turbine disk accuracy would more than offset the maintenance gain.

General Electric's overhaul facility at Evendale was established in 1952 and has grown to a capacity of 350 engines per month from its original capacity of 105 per month. The effort has been directed towards increasing the systemization of the overhaul line. The result of this systemization, says Denison, has been cutting down the engine cycle time through overhaul.

Boeing selects new Westinghouse electrical system for 707

AIRLINES ASSURED MOST ADVANCED PERFORMANCE BY NEW BRUSHLESS GENERATOR, NEW MAGAMP* REGULATOR, NEW STATIC CONTROL PANEL

Boeing engineers will achieve both *system reliability* and *reduced maintenance* for the new 707 Strato-Liner as a result of choosing integrated a-c systems developed by *Westinghouse*.

The rotating rectifier a-c generator eliminates commutators, brushes and collector rings. It does away with the troublesome maintenance problems that these components force on other systems. Excitation is self-contained in the generator—no vulnerable power cables between the generator and exciter. Static circuitry gives sealed-in accuracy, assures system reliability.

The systems are tailored to meet the requirements of the airlines using three or four generators rated 30 or 40 kva, and, of course, the systems have automatic protection.

Contact your Westinghouse sales engineer for complete information about this new integrated electrical system, or write: Westinghouse Electric Corporation, Aircraft Equipment Department, Lima, Ohio. J-03028

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to 20 days from the original 40. The goal is 12 days.

The money, time and effort necessary to build this overhaul facility makes Denison somewhat dubious that even the big airlines really would be willing to spend the several millions necessary to continue their present policy of keeping their engine overhaul "in house."

Reasons why jet engine overhaul is so expensive appear to center around the need to get a high cost, complex item back into revenue producing service in the minimum time with the greatest assurance of operating reliability. To do this with the manpower levels which are realistically available demands a heavy investment in fairly specialized equipment such as chemical and ultrasonic cleaning equipment, elaborate fuel system test benches, rotor balancing rigs and spin pits, compressor and turbine blade reconditioning equipment, tailored jet engine assembly and handling tools and accurately instrumented, sound-proofed test cells.

Current talk on the problems of introducing jet transports into commercial aviation indicates that while the jet transport could be a very big money maker in the air if all goes well, it won't take too much time on the ground to put the operation in the red.

Other speakers, with backgrounds in both military and commercial overhaul, emphasized that those airlines contemplating their own overhaul facilities should get started on them right now—any delay will make them too late for the present introduction schedules of the new jet transports. This is because the many peculiarities and large scale operations which are needed for jet engine overhaul prevent the job being done overnight, or even in a couple of year's time.

Needs listed included real estate (from the standpoint of space and neighborhood objection to noise), sewage disposal of cleaning chemicals (which is drastically curtailed by governmental restrictions in certain localities), cooling and cleaning water, and trained skilled labor. These are part of the longer range contingencies which must be planned for now.

Furthermore, intelligent planning at this time can result in considerable savings. TWA plans to use the test cell exhaust; stack cooling water heated by the exhausts of the overhauled engines on check-out runs to substitute for a heating plant for their overhaul building.

The worst part of the jet transport overhaul picture may come early in their introductory phase since the new engines are expected to have shorter use durations between overhauls (500 hrs is a present estimate).

PRODUCTION BRIEFING

Stanley Aviation Corp, Denver, Colorado, is doubling its facilities to 30,000 sq ft for the manufacture of airplane ejection seats for USAF. Other air crew escape devices also are under consideration.

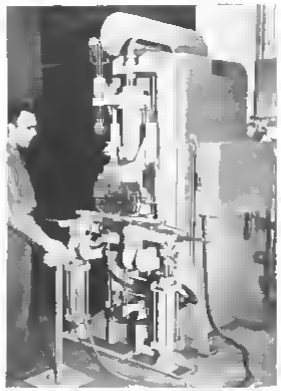
Boeing Airplane Co, Seattle, reports that standardization of scaffolding saved more than $500,000 on its tooling program for the KC-135 jet tanker transport. Scaffolds, which permit the workers to reach various parts of the airframe were formerly custom-built for each job. Now Boeing has set up standardized scaffolding which can be tailored "erector-set" fashion for each job. Each scaffold platform is equipped with its own lighting, electrical and compressed air outlets, and fire extinguishing sprinkler system.

Detroit Broach and Machine Co. is building a fifteen thousand sq ft addition to its plant in Rochester, Mich., because of the increased need for broaching tools.

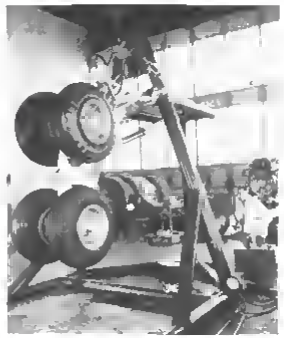
Ultrasonic soldering is claimed by Acoustica Associates Inc., Glenwood Landing, N. Y., to be more effective in some cases than chemical fluxes in assuring a good bond. The ultrasonic vibrations are said to cavitate and erode the oxide which must be removed before the solder can unite with the parts. Shown above is an Acoustica Mullard ultrasonic soldering iron being used to fill in a blow hole in an aluminum casting. This method can join aluminum to itself and its alloys as well as to dissimilar metals such as brass or steel.

Self-feeding automatic power screw driver puts in screws at any angle as fast as the operator can pull the trigger, according to the maker, the Shakeproof Div., Illinois Tool Works, Elgin, Ill. Called Semspak (R), the driver's cartridge holds sixty #8 screws (slightly less #10's) and will accommodate lengths from ⅜ in. to 1½ in.

Mallory-Sharon Titanium Corp, Niles, Ohio, will use this vacuum furnace, which they say is the largest of its kind, for reducing hydrogen content and annealing titanium sheet before shipment. The furnace has a charge space of 4 x 4 x 12 ft., can process several tons per charge, a maximum operating temperature of 1600°F, and can be evacuated to one-millionth of an atmosphere. It was built for Mallory-Sharon by Westinghouse Electric Corp. Radiation elements provide the heat and radiation shields supplant the usual refractory brick and thermal insulation.



Pines Engineering Co., Aurora, Ill., uses a six ton tube bending press to handle up to 1 in. O.D. steel tubing. The press makes 1,700 to 3,000 bends per hour.



Canadair, Ltd., Montreal, Canada, checks out four wheel bogie linkage for their CL-28 (RCAF CP-107) coastal patrol aircraft which is being built for the Royal Canadian Air Force. This experimental set-up was part of Canadair's program in redesigning a Bristol Britannia for patrol useage.

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parts in an inert atmosphere inside this pilot plant at its Bridgeville Pa., research and development center The enclosed room, Universal says will make it possible to heat and form molybdenum and other refractory metal ingots into forged and rolled products in an inert gas atmosphere between 3500 to 4000F Moly which melts at 4,700F tends to corrode excessively when it reaches temperatures where it can be worked The room will have three air locks—one for equipment one for supplies and one for personnel The first two will be conventional tunnel structures with gas tight doors at either end and pumping equipment to exhaust air The air lock for personnel will consist of two doors lined with diaphragms conforming closely to the shape of the human body Air-cooled space suits will be required Inside the room they will hook up to intake and exhaust manifolds Two crash doors are added for emergencies Universal-Cyclops is constructing the new plant in conjunction with the Navy s Bureau of Aeronautics and expects that it will be in operation by 1957

Baldwin-Lima-Hamilton Corp. SR-4 gages installed in overhead crane pickups saved over 40% time in weighing materials for inventory control according to Channel Master Corp., Ellenville, N J Meter in crane operator's cab allows him to take inventory records as he moves material down the production line

NAA's New Building

New North American Aviation Building at Los Angeles will be located at International Airport Structure will have 11,118 sq ft of porcelain enameled aluminum fascia supplied by California Metal Enameling Co Porcelain enamel was chosen for durability, resistance to color fading, corrosive action of salt sea air

WHO'S WHERE

(Continued from page 23)

Changes

Thomas B Schmille, operations manager and Capt. John S Haerper (USN ret.) assistant to the vice president general manager Hoover Electronics Co., Baltimore, Md.

Benjamin Parran, project leader, technical military planning operation, General Electric Co., Santa Barbara, Calif.

William Sendell, general products manager, Red Bank Division, Bendix Aviation Corp., Eatontown, N. J.

Harold R. Suter, technical director, J. B. Ford Division, Wyandotte Chemicals Corp., Wyandotte, Mich.

France Q. Wilson, manager turbine and control sales, Solar Aircraft Co., San Diego, Calif.

James J. Welker, vice president operations, Clevite Corp., Cleveland, Ohio.

Frank J. Smith, vice president, Columbus Bolt & Forging Co., Columbus, Ohio.

J. V. Connelly, administrator of training instrument school, Kollsman Instrument Corp., Elmhurst, N. Y.

Stuart H. Goldsborough, district sales manager (New York), Slick Airways, Inc.

Dr. Earl L. Steele, chief development engineer, Development Dept., Semiconductor Products Division, Motorola, Inc., Chicago, Ill.

Everett W. Thompson, supervisor of turbo prop contracts, Allison Division, General Motors Corp., Indianapolis, Ind.

Jules Pond, application engineer, accessories department, Propulsion Research Corp., subsidiary of Curtiss-Wright Corp., Santa Monica, Calif.

Dr. Robert F. Buchele, staff assistant to Western Division manager, Servomechanisms, Inc., Hawthorne, Calif.

Conrad Hohmann, assistant chief engineer-special airborne devices, Vickers, Inc., Detroit, Mich.; also B. W. Bidenoch, manager aircraft product sales, Vickers aviation gas turbine components group.

Capt. Frederick O'Vaughan (USN ret.) assistant director supply for the DEW line, Federal Electric Corp., Clifton, N. J.

Edward Foodim, chief engineer, Consolidated Avionics Corp., Westbury, N. Y.

Edmund Stohr, European director (London, England), United Air Lines. Mr. Stohr succeeds James B. Miller, now manager of government and military sales.

Perry A. Warren, factory manager, Eugene J. Raymond, contracts manager, and George G. Cudhea, assistant to the vice president-general manager, Defense Division, Kaiser Metal Products, Inc., Bristol, Pa.

Ben E. Sherwood, director-airmail and air express, American Airlines.

Alexander S. Jerreims and John R. McCharles, assistant directors, fire control systems laboratories, Hughes Aircraft Company, weapon systems laboratories, Culver City, Calif.; also Michael E. Hiehle, project manager, Weapon Systems Development Laboratories, and Dr. Morris Feigen, senior staff engineer, Design Integration Department, Guided Missiles Laboratory.

Irving Roth, assistant to the president, and J. Grant Macdonnell, assistant treasurer, Northrop Aircraft, Inc., Hawthorne, Calif.

PROGRESS REPORT ON PROJECT VANGUARD

General Electric X405 Being Readied For Flight Testing

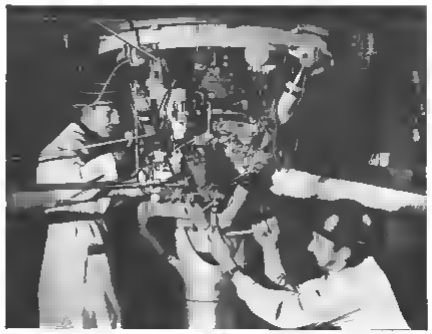
"Flyable" model of G-E rocket engine on schedule at fully instrumented Malta, N. Y. rocket test station

General Electric's new X405 rocket engine has already completed many successful static test runs—only a year after General Electric was awarded a contract to build the first-stage powerplant for the VANGUARD rocket. Now being qualified for flight test, the G-E X405 is scheduled for early delivery to Martin-Baltimore, builder of the VANGUARD airframe and prime contractor for the earth satellite launch vehicle.

When the bi-liquid X405 launches the finless, three-stage VANGUARD rocket during the International Geophysical Year, it will produce more than 27,000 pounds of thrust and have a burning time of about 150 seconds. At burnout 36 miles above the earth, the X405 rocket engine will have accelerated the VANGUARD rocket to a speed of 4000 mph—more than a mile a second!

The advanced G-E powerplant is currently undergoing detailed qualification testing at the Malta, N. Y. rocket test station, operated by General Electric for the U. S. government. Fully instrumented, Malta's advanced engine and component testing facilities have enabled G-E rocket engineers to make rapid progress in the development of the X405.

Superior performance of G.E.'s X405 is the result of more than a decade of General Electric rocket engine experience. The new powerplant marks another milestone in G-E rocket engine progress, is another example of how General Electric today can provide the U. S. rocket and missile industry with highly reliable, high performance rocket engines . . . of unmatched quality. ***General Electric Company, Cincinnati 15, Ohio.*** 234-9



FULL ENGINE SYSTEMS TESTS simulate X405 flight requirements, duration of actual VANGUARD first stage run. Above, G-E technicians install X405 engine in rocket test pit in Malta.

X405 ENGINE RUNS ARE CONTROLLED from blockhouse, adjacent to firing pit. Completely instrumented test cells record continuous performance data during close-to 150 second run.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Auto-Tester Finds Fault, Details Repair

By Philip J. Klass

Automatic line maintenance testers can now be designed which will enable a relatively unskilled operator to check out practically all of the avionic, hydraulic and pneumatic systems in an airplane or missile in less than 30 min., according to Sperry Gyroscope Co.

The equipment can tell the operator not only which elements are at fault but where to find a replacement, the tools needed, procedure to be followed, and an estimate of airplane/missile down time for the operation.

Thus more avionic equipment, not less, may be the answer to current pressing military maintenance technical manpower and training problems.

Under Development

Systems capable of performing many of these tasks for a variety of different weapon systems and subsystems are now under development at Sperry and elsewhere. The techniques needed to build the sophisticated check-out system described above, which tells everything but the operator's age and weight, either exist today or are close at hand, according to Sperry. The company recently demonstrated a working mock-up of such a system which it calls RACE—Rapid Automatic Check-out Equipment.

RACE will be designed to calibrate itself before each measurement and to check its own performance at periodic intervals. If it discovers an internal fault, it will automatically pinpoint the faulty element just as it does when testing a weapon system.

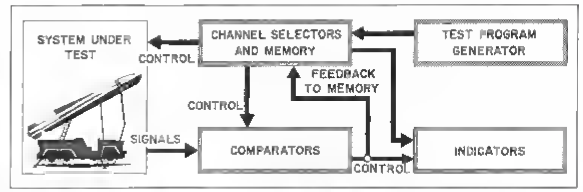
Change in Thinking

Biggest obstacle to early and widespread use of RACF-type systems is not technological but rather the revolutionary change in military and industry thinking and organization which must take place.

For example, development of the automatic check-out equipment must be launched simultaneously with that of the weapon system it is to test, not several years later.

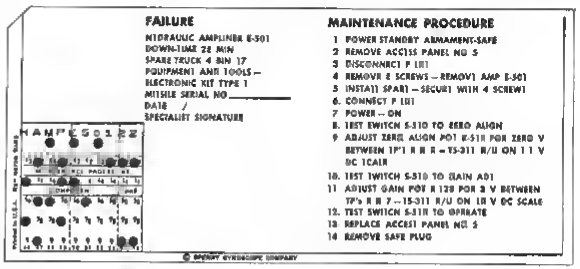
The weapon system must be designed to permit the automatic tester to gain easy and speedy access to critical voltages and circuits, and this may add to the cost, size and weight of the weapon system.

Extremely competent engineers with wide knowledge in the weapon systems field must be assigned to the task of



RAPID AUTOMATIC Check-out Equipment (RACE) can test and trouble-shoot avionic, hydraulic, pneumatic equipment aboard an airplane or missile in matter of minutes.

PUNCH CARD turned out by RACE identifies faulty element, tells where to find replacement, how to make repair, what tools are needed, and estimated airplane/missile down-time.



designing automatic check-out equipment. And if the system is to perform the functions of test equipment, instruction book, and even supply (as it potentially can), development responsibility will cut across the line of activity of a number of different groups both within military and industry organizations, and this must be resolved.

Growing Activity

Despite these problems, Sperry is convinced that the RACE type approach is the logical answer to the growing complexity of military weapon systems. It has backed this view with considerable company money to carry out basic research and development in this field, according to David Keim, engineering department head of Sperry's Microwave Electronics Division. This work is centered in the division's Weapon System Support Section which is developing automatic test equipment for both its own programs and for weapon systems of outside contractors.

Sperry is far from alone in this field although from public disclosures to date it appears to be one of the leaders. Other firms known to be active or interested in developing automatic line maintenance check-out equipment, of varying degrees of sophistication, include Associated Missile Products, Color Television, Electro Instruments, Farnsworth, General Electric, Motorola, Northrop Aircraft, North American's Autonetics Division, Polarad, and Stromberg-Carlson.

Maintenance Automation

Seven years ago Sperry began the study of the design of a semi-automatic tester for a radar system. Subsequently it built semi-automatic field testers for a Navy fire control system and the Army's Skysweeper anti-aircraft system.

During this period industry was developing new techniques for use in electronic digital computers. Sperry recognized that these could open the door to fully automatic testers greatly speeding the check-out of a weapon system.

In 1955, Sperry decided to take a systems-engineering look at the overall problem of automatic check-out and the possibility of developing basic techniques and hardware which could be applied to a variety of weapon systems. This study indicated that nearly all of the manual time-consuming steps in line maintenance could be performed automatically, and thus far more quickly, using fewer and less skilled personnel.

A brief review of present line maintenance procedures will point up the way in which the operation can be automated. In many aircraft now operational, each major sub-system requires its own specialized piece of test equipment and often its own specialist to operate it. When the tester has been connected into the system, the operator must:

(1) Read test instructions to determine required switch positions and operating sequence.
(2) Set tester controls to specified positions.
(3) Read tester instruments.
(4) Compare this reading with those in test manual to see if correct value has been obtained.
(5) Decide what test should next be made, based on previous reading, to isolate system malfunction.
(6) Repeat steps 1, 2, 3, 4 and 5 until fault has been isolated to one element of the system.
(7) Locate replacement part and instruction book that gives installation and adjustment procedure.
(8) Replace defective element.
(9) Run through complete check-out procedure to assure system is operating satisfactorily.

The use of "Go, No-Go" type indications on some recent line maintenance

Giant Tube

Giant klystron tube, measuring more than 10 ft. in height, can generate 100 kw. average power and more than one megawatt of peak pulse power. The new X626 klystron, intended for radar and linear accelerator use, is called the largest tube ever developed by its maker, Eitel McCullough, Inc., San Bruno, Calif.

ance testers has simplified the foregoing to a moderate extent.

In Sperry's RACE operating instructions and the test program can be stored on punched tape, cards, or magnetic tape according to Arthur Witten engineering head of the Weapon System Support section. This assures that the tester, unlike a human, will always follow the same systematic test procedure without having to make reference to instruction manuals. It replaces step (1) above.

Automatic switching devices, operated by the taped program, connect into the desired circuit of the system under test, introduce the required signal and bring out the resulting signal, corresponding to step (2) above. If the test requires a lengthy warm up or stabilizing time, RACE goes onto succeeding tests, comes back later for the desired measurement.

The measured signal is automatically compared with the desired value that is stored on the program tape and a decision automatically made as to whether the measured value is within acceptable limits. This task, corresponding to steps (3) and (4), is not easy for dynamic signals whose magnitude changes with time.

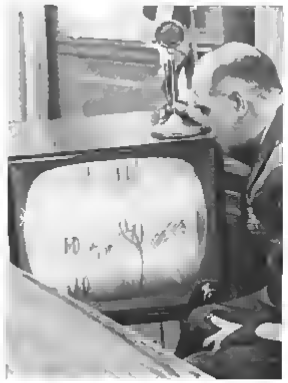
Logical Decisions

If the measured value is outside allowable limits, indicating a fault, RACE will automatically shift to another program (sub-routine) stored on another tape to obtain instructions for subsequent tests needed to track down the fault. This corresponds to Steps (5) and (6) above.

To pinpoint the source of the fault may involve RACE decisions based on moderately complex logic, according to Witten. For example, the decision may depend upon the inter-relationships of several measurements. For this reason,

Weathervision Display

At Central Air Defense Force Headquarters, Grandview AFB, Mo., closed circuit TV and two way communications to a central 'Weathervision' station make it possible to display weather charts and give weather briefings at 10 remote points, such as the alert hangars and ready room. (See photo right) Central forecaster can answer requests from any of the 10 receiver stations now in use. Closed-circuit TV equipment, was designed by Dage Television Division of Thompson Products Inc. Closed circuit TV in combination with a microwave link recently demonstrated the feasibility of remoting the radar scope presentation from an AN/CPS 9 storm detector radar, showing weather conditions over a 200 mile radius, as well as weather chart displays. (See photo above)



RACE must be equipped with an interim (short term) memory for storing one or more interim decisions until needed for cross comparison with others to reach a final decision.

RACE is not intended to track down the fault to a specific resistor or tube—only to the smallest black box or subassembly which it is practical to replace at the squadron level.

On this basis there are only a moderate number of different possible faults, perhaps up to 500 in a very complex weapon system. Each fault can therefore be catalogued, and recorded on a strip of microfilm and on cards, with a separate frame or card for each type fault. Once RACE has pinpointed the malfunction, it will automatically select the corresponding microfilm frame and display it on a screen at the operator's console. (See photo p. 97.) Simultaneously the console will dispense a punched card with corresponding data printed on it.

Valuable Information

The data on the microfilm and card are intended to provide the maintenance man with a variety of information which otherwise he would have to dig out of the instruction book for the equipment under test and is therefore a great time saver. The following is an example of the type of information that could be printed on the card, according to Witten:

- Faulty element and its part number.
- Estimated down-time to replace.
- Location of replacement part in spare-parts truck or warehouse.
- Equipment and tools needed for the operation.
- Detailed replacement procedure and subsequent adjustment. Procedure includes list of switches or controls which must be turned off for safety.
- Technician type needed to make the repair.

Sperry believes that the card will be returned with the defective unit to the overhaul station. If the unit cannot be repaired, the card with pre-punched holes that identify the defective part, can be introduced into an electronic inventory data processing system now being developed for military use where it will automatically order out a replacement from the nearest supply center.

Present Status

Sperry is developing a number of check-out equipments for both its own systems and for outside weapon system contractors. One of these, for example, will test a very complex bombing-navigation system, another is for a missile guidance system.

While these generally employ automatic programming and decision-making techniques, some of the decisions must be made by the human operator. However, Keim says that these systems could be made fully automatic if the customer so desired.

One of the most difficult problems associated with the design of automatic decision-making in a check-out equipment arises when the signal being measured varies with time, and when the allowable tolerance from the ideal wave shape also varies with time. However, Sperry has developed techniques which it says can make such comparisons automatically.

The systems which Sperry presently is developing have no provision for display or dispensing cards with the aforementioned maintenance data. They will merely track down and identify the faulty element by an arbitrarily assigned number or letter identification. Once this stage is reached the addition of the maintenance display card feature poses no technological problems, Witten says.

Sperry has applied automatic check-out techniques to a variety of types of avionic equipment, including radar fire control systems, power controls, flight stabilization systems, radar beacon and IFF equipments, electronic counter-measures, and data handling systems, according to Herbert Hilperin of the Microwave Electronics Division.

Sperry has not limited its objectives solely to automatic check-out of avionics equipment. It plans to include hydraulic, pneumatic systems and even "cold testing" of propulsion systems.

A major problem in automatic check-out of both avionic and non-avionic equipment can be greatly simplified if the equipment is originally designed for such operation. This includes making provision for easy access to critical circuits and the possible addition of devices used solely for automatic testing and not required for normal equipment operation, Witten says.

GE Concepts

General Electric's Light Military Electronic Equipment Dept. has been a pioneer in the development of automatic test equipment for production line testing of complex avionic systems in the factory. (AW Aug. 8, 1955, p. 61.) LMEED believes that these techniques can be easily adapted for line maintenance check-out equipment.

In one GE proposal for an automatic tester for a fire control system the test program would be stored on a punched tape and a digital voltmeter would be used for basic measurements and to convert them into digital form.

The device would give the operator a 'Go' 'No Go' indication after each test and simultaneously record the measured value on a punched tape. The tape later would be used to print out a daily record of critical system per-

formance measurements for each airplane or missile. Scanning this chart for any single weapon would enable an observer to detect performance deterioration before it reached a point sufficient to cause system failure.

In addition to its many advantages for the military services, automatic field test equipment should make it possible for avionics manufacturers to obtain reliable quantitative data on the field performance of their equipments—data that is invaluable in improving the product and eliminating causes of unreliability.

Because automatic check-out system development must proceed concurrently with its associated weapon system design changes in the latter during the course of its long development cycle may result in changes in the tester design. However, Sperry believes this is not too stiff a price to pay for the many advantages of automatic check out systems.

Expansions, Changes In Avionics Industry

Bendix Aviation Corp. has formed a new Bendix Systems Division at Ann Arbor, Mich., which will concentrate on weapon system requirements for Defense Dept.

New division will occupy leased space near University of Michigan but expects to build and occupy new facility there by August 1958. The operation is headed by Dr. Russell D. O'Neal, former director of systems planning for Bendix. Within three to five years Bendix says it expects new division to employ 1,000 scientists, engineers and supporting staff.

Other recently announced avionic industry expansions and changes:

• **Nucleonics Products** is name of new San Diego firm specializing in aircraft/missile instrumentation systems and precision tooling and parts. Facilities and production management of the National City Machine Co. and San Diego Machine Co. have been combined in the new firm which is headed by C. L. Rubesh.

• **Aircraft Radio Corp.**, Boonton, N. J., has opened its new $50,000 engineering laboratory.

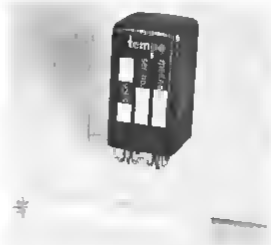
• **Cambridge Thermionic Corp.**, Cambridge, Mass., has formed new Canadian Affiliate, Cambridge Thermionic of Canada, Ltd., located at 2525 Grand Blvd., Montreal 28, P.Q., to market all of the company's products.

• **Polytechnic Research & Development Co., Inc.**, Brooklyn, N. Y., maker of microwave test equipment, has acquired an additional floor in present building located at 202 Tillary St.

NEW AVIONIC PRODUCTS

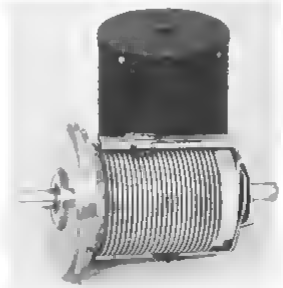
Components & Devices

• **Miniature time delay** relay, measuring 1 x 1 x 1¼ in. and weighing less than 2 oz., is available with time delay periods of 0.1 to 5.0 sec., accurate to within 10% over temperature range of 55C to 125C with input voltage variations of 10%, according to manufacturer. Models are available for

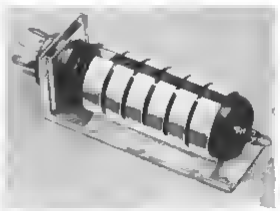


voltages from 28 v.d.c. to 150 v.d.c. or 26 v.a.c. to 115 v.a.c., 60 to 400 cps. Unit comes with DPDT contacts rated at 2 amps resistive load. Unit can be instantaneously recycled without change in time delay. Tempo Instrument Co., 5 Centre St., Hempstead, N. Y.

• **Ultra-precision potentiometer**, Model MD20, provides linearity up to 0.01%. Unit employs helical construction, measures 2 in. diameter with length of approximately 1¼ in. for 10 turn pot, or 2¼ in. for a two gang 10 turn pot. Unit comes in resistance values of



1,000 to 100,000 ohms. Torque on dual sections is as low as 1½ in. oz. Litton Industries Components Div., 5873 Roden Rd., Los Angeles 16, Calif., and 215 S. Fulton Ave., Mt. Vernon, N. Y.



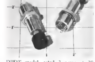
• **Miniature tube clamp** with integral socket, comes in types 6A4 for 7 pin miniatures and 6A5 for 9 pin miniature tubes. Slotted finger sleeve is made of heat treated silver alloy for maximum conductivity. The Butcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif.

• **Subminiature twin triode**, Type CK6832, designed especially for d.c. amplifier and computer applications to provide extremely low microphonics and grid current. Tube characteristics are electrically similar to Type CK5755. Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass.

• **Direct-reading frequency meter** for panel mounting is available for any center frequency from 40 to 10,000

cycles and covers range of ± 20% from center frequency with accuracy of 0.25% of center scale reading. Unit can operate from voltages of 80 to 500 and its accuracy is not affected by 10% variation of input voltage. Meter comes in several sizes ranging from 2¼ to 6 in., both round and square. Meter, produced by Electrical Instrument Co. Ltd., of Scotland, is available in the U. S. from Gary Wells Co., 3 Park Row, New York 38, N. Y.

• **Miniature pushbutton switch** for computers, calculators or other devices using banks of adding machine type key switches, has smooth non-snap action and responds to operating pressure of only 8 oz. Switch comes in



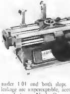
DPDT model, rated 3 amps at 28 v.d.c. and measures ⅝ in. dia. x 2⅛ in. Complete specifications on the B5023 switch are available from Hetherington, Inc., 1200 Elmwood Ave., Sharon Hill, Pa.

Microwave Components

• **Miniature S-band cavity oscillator**, Series 500, for pulse or CW operation, has tuning range of more than 200 mc with peak power output of 1-2 kw., depending upon frequency, operating at a 0.001 duty cycle. As a CW cavity oscillator, unit has tuning range of more than 200 mc and a power output of 50 mw. in upper range, 100 mw. in lower range. Tuning is accomplished by a screwdriver adjustment. Unit can operate under 10G vibration at 2,000 cps., measures 7 in. long by 1¾ in. dia., weighs 25 oz. including GL-6442 tube. Amerac, Inc., 116 Topsfield Road, Wenham, Mass.

• **Variable calibrated attenuator**, with calibration accuracy of 0.2 db., provides up to 40 db. attenuation with VSWR of 1.15. Attenuator is micrometer driven and dissipative element is evaporated nichrome film on glass plate. Admittance Namco Corp., Farmingdale, L. I., N. Y.

• **Portable slotted lines**, Models 319 to 324, incorporating carriage drive mechanism integral with waveguide assembly cover the frequency band of 2.6 to 18 kmc. Residual VSWR is



under 1.01 and both slope and slot leakage are imperceptible, according to manufacturer. Narda Corp., Mineola, L. I., New York.

Computer Devices

• **Information delay generator**, Model 3770, for use with analog computers, accepts input signal of ± 100 v. varying with time and delivers same information at output terminals delayed in time from 0.02 to 2 seconds. Delay interval is linearly adjustable. Input waveform is faithfully reproduced for all frequencies from d.c. to the inverse of the delay interval. Another model comes with delay interval up to 20 seconds. Donner Scientific Co., Concord, Calif.

• **Acoustic delay unit**, Model AD1, operates at repetition rates up to 1 mc and is available with delay periods up to 1,100 microseconds. Maximum storage capacity is 1,100 bits of information. Output is at a 91-ohm impedance level. Unit is intended for 19 inch rack mounting and measures only 1¾ in. in height. Quartz delay element is temperature controlled to provide delay accuracies of 0.1 microseconds. Computer Control Co., Inc., Wellesley, Mass.

Quartz Crystal Supply

In event of all-out mobilization, the nation does not have facilities to produce enough quartz crystals for military communications equipment. This disclosure, based on preparedness studies, was made during a recent meeting in Washington between government and industry officials.

Manufacturers' representatives pointed out that military practices of buying crystals on a low bid basis are driving manufacturers to cut throat competition, in some cases forcing them to sell below cost. Industry representatives called for negotiated procurements and government financial support to buy new machinery needed to meet mobilization requirements.

Defense Department officials will visit manufacturers soon to determine what additional facilities are required.

New Avionic Bulletins

• **Electronic data processing system**, ALWAC 800, a low-cost system is described and full specifications given in bulletin entitled "Data For Decision." Logistics Research Inc., 141 So. Pacific Ave., Redondo Beach, Calif.

• **Minitron differential transformers**, with infinite resolution covering range of ±0.005 to 2.00 in. for operation of temperatures of 105C or 260C on special order. Price and specification sheets. Minitron Corp., Belle Mead, N. J.

• **Cathode ray oscilloscopes** and associated equipment. Catalog (8 pp.). Tektronix Inc., P.O. Box 831, Portland 7, Oregon.

• **Instruments for analysis**, control and data processing. General catalog (92 pp.). Consolidated Electrodynamics Corp., 300 No. Sierra Madre Villa, Pasadena, Calif.

• **Microwave ferrite devices** including isolators, attenuators and modulators (4 pp.). Sperry Gyroscope Co., Microwave Electronics Div., Great Neck, N. Y.

• **Use of digital techniques for testing** data processing and control are described in novel 16 page booklet entitled "Four Dimensions in Digital Design—Pulse Techniques for Modern Control." Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Philadelphia 7, Pa.

• **"Miniaturization of Aircraft Circuit Breakers"** is title of new brochure describing MP 700 series of aircraft circuit breakers. Mechanical Products, Inc., Jackson, Mich.

• **"Operation of Coincident Current Ferramic Magnetic Memories"** is title of Technical Bulletin MM-1 available from General Ceramics Corp., Keasbey, N. J.

• **Threshold indicator**, Model 91200-1, a device which will sound an alarm when radio interference exceeds the limit of MIL specs, is described in bulletin available from Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.

• **Servo Corp. of America facilities** for research and development are described in 4-page bulletin entitled "Research and Engineering." Servo Corp. of America, 20-20 Jericho Turnpike, L. I., N. Y.

• **Synchro tester for field use**, Type C-1, described in two page bulletin. Aero Electronics Co., 1512 No. Wells St., Chicago 10.

• **Electronics Facts Handbook**, a 20 page pocket-size collection of reference material including AN nomenclature system for electronic equipment, radio spectrum assignments. Write on company letterhead to: American Machine & Foundry Co., Public Relations Dept., 261 Madison Ave., New York 16, N. Y.

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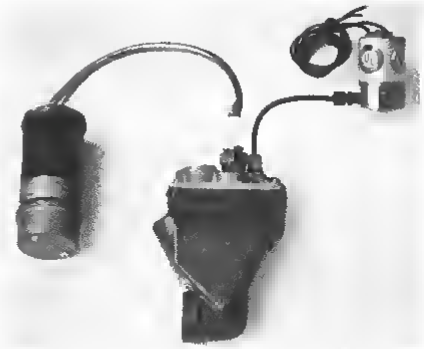
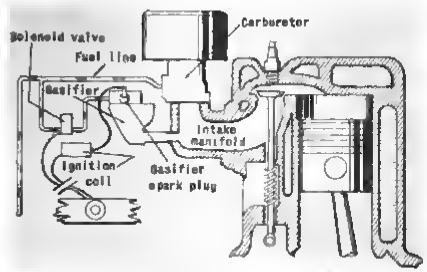




BASIC COMPONENTS of gasifier unit include combustion chamber, solenoid valve and ignition coil. Diagram shows typical installation.

New Primer Aids Engine Starts In Chill South Pole Temperatures

By George L. Christian

New York—A new priming device to aid engine starting after long exposure to chilling temperatures currently is being tested on a de Havilland Otter with Adm. Richard E. Byrd's expedition at the South Pole.

The compact, light-weight device, called a Gasifier, is mounted on the engine's intake manifold downstream from the carburetor. It instantaneously supplies fuel in the form of a hot, fixed gas to all cylinders as soon as the engine starting process is initiated, allowing the powerplant to fire up to 650% more rapidly than if standard priming methods were used. Engines have been started with the device in 30 seconds or less after exposure in temperatures as low as −65F.

The unit is going into production at The Robert Reichhelm Co. with initial production rate of 100 units per month anticipated.

Tests conducted on a Ford V-8 and Chrysler C-36 standard industrial engine by the Department of the Army in a cold room of the Engineer Research and Development Laboratories, Fort Belvoir, Va., at temperatures down to −65F resulted in these conclusions and recommendations:

- **Starting the engines** at sub-zero temperatures could be accomplished in a minimum length of time (30 sec.) with gasifier installed.
- **Installation** of the gasifier on a gasoline engine is simple and compact.
- **Maintenance of** the gasifier is routine and inexpensive. Moreover, it requires no extra accessories and uses the same fuel as the engine.

The Army made two recommendations:

- **That the gasifier** be installed on gasoline engines and field tested under arctic conditions.
- **That future tests** incorporate a blower to force the vaporized fuel into the cylinders in an attempt to reduce cranking time which can be critical when batteries are used to start engines under conditions of extreme cold.

In another report this one on Diesel engines made by Penn State University, the gasifier was stated to "give smooth combustion with no audible knock. Distribution was very good between cylinders and all cylinders fired during gasifier operation. The operator always had control of his engine and at no time did engine speed become excessive."

Gasifier Features

Here are some of the more important features of gasifiers:

- **Applies to all sizes of** gasoline engines from 100 cu. in. displacement. It also may be used on Diesel engines above 50 cu. in. displacement.
- **Reduces appreciably** the drain on batteries caused by prolonged cranking at sub-zero temperatures when crank case oil is stiff and battery performance is marginal because of the cold. Tests on a gasoline engine under identical conditions at −40F with and without a gasifier showed the device reduced cranking time as much as 650%.
- **Lasts almost indefinitely** because it has no moving parts to wear out. The spark plug requires periodic cleaning and changing.
- **Fits easily** on most engines because of its small size; dimensions are 7 x 4¼ x 2¾ in. Weight is approximately 6 lb.
- **Operates exactly** as a conventionally equipped gasoline engine, thus requires no change in operator technique.

Gasifier Description

Robert Reichhelm, company president describes the device this way: "The gasifier through its self-contained heat generator instantly converts part of the fuel entering into its heat chamber into a combustible, stable fixed gas. (A fixed gas is one which will not condense except at abnormally low temperatures). The instant conversion into gas eliminates flooding and resultant starting failures."

This is how the gasifier works: When the starter button is pushed (or other starting procedure initiated) a solenoid-controlled valve diverts fuel from the carburetor to the gasifier metering the fuel being pumped to the device. Simultaneously, the gasifier's spark plug is energized. The plug ignites the fuel passing through the gasifier only a small part of which is allowed to burn since not enough air is admitted to permit complete combustion.

Unburned Fuel

The remaining unburned fuel passes through the burning gas in the device where it is instantly heated, vaporized and turned into a fixed gas such as methane. Reichhelm explains that this fixed gas is produced by a thermal cracking process which occurs as the liquid fuel passes through the flame zone of the gasifier.

The fixed gas can be piped a considerable distance, even in extreme cold without danger of condensing on cold combustion chamber walls. However, since the heat of the gas is also a factor in quick starting, the gasifier should be mounted close to the intake manifold and in such position

where it will provide the most even distribution possible to all cylinders.

Air for the engine's operation comes through the carburetor.

The engine may operate from the gasifier as long as necessary. When the power plant is sufficiently warm, the solenoid valve may be shut off, cutting out the gasifier and putting the carburetor into operation.

The Navy, first major customer for the gasifier, will use the device on automotive equipment as well as the Otter in Adm. Byrd's Operation Deep Freeze, according to the manufacturer.

Reichhelm currently is financing expansion of his manufacturing facilities at Wallingford, Conn.

New IBM Computer Used at Mathieson

Niagara Falls, N. Y.—A new IBM computer has been installed at the Aviation Division laboratories of Olin Mathieson Chemical Corp. for research studies on development of high energy chemical fuels.

The new computer, known as IBM 650, will analyze experimental data and solve complex mathematical problems at split second speed. The computer will be used to calculate chemical equilibrium constants, reaction temperatures, and enthalpy and entropy of chemical compounds which are of potential interest in the field of high energy fuels.

Company presently is studying the oxidation reactions of over 200 such compounds.

The division recently announced plans for construction of a $36 million high energy fuels plant for the Air Force at Model City, N. Y.

The 650 computer is what is known as a magnetic drum digital type. The Olin Mathieson installation includes, in addition to this machine, a read and punch unit, two key punch machines, sorter, reproducer and accounting machine.

About 25 of the company's chemists, physicists and engineers have been given training in the use of the machine.

Cutter Designed to Disarm Ejection Seat

New cutting tool is specifically designed to allow rescue crews to disarm quickly the ejection seat systems of crashed military aircraft. Called the AT 501 Cable Cutter, the tool can remove a ¾ in. section of ½ in. armored initiator hose, stainless steel tubing or steel wire. It features a swivel head which permits the user to turn the handle and frame to the best position for fast disarming. Manufacturer: Aircraft Tools Inc., 9030 Bellanca Ave., Los Angeles 45, Calif.

Airstream Reels Out Target 5-Mi.

Hawthorne, Calif.—Target-tow reel system capable of trailing a radar reflecting target approximately five miles behind the tow plane is now undergoing tests at the Air Force's Rocket Training Center, Vincent AFB, Yuma, Ariz.

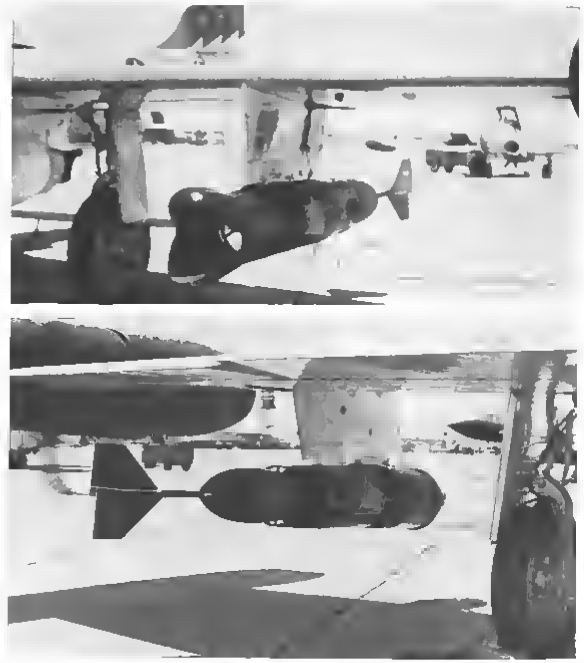
Designed for use in gunnery and rocket training with supersonic jet aircraft, the tow target system, known as Bee Jay, was developed jointly by Air Force and Northrop Aircraft, Inc. The increased tow range of the system allows a greater margin of safety during high speed passes on the target.

Target is a low drag torpedo-shaped Fibreglas shell capable of casting a radar reflection simulating the size of the biggest bombers. A 10 in. corner aluminum reflecting disk is set in Styrofoam. Rear fins on the target spin it for maximum reflectivity and stabilization. Weighing 15 lb. and measuring 20 in. in diameter and less than 10 ft. long, the target is released from the rear of the reel unit which stays with the towing aircraft. A direct hit on the target shatters it.

Jettisonable reel system weighs 290 lb. including its 4 in. steel cable, which has a length exceeding 25,000 ft.

Power for the reel is furnished by the airstream driving against a turbine wheel. Clamshell doors on the nose of the reel unit open and close to control in and out operation of the cable. Target, or cable alone if target is shattered, can be reeled back.

The target tow reel system can be adapted to almost all operational type aircraft. First of the units have been installed on Northrop F-89 interceptors. Only minor adjustments were required for fitting to one of the mid-wing pylons to replace the auxiliary fuel tank normally carried on the aircraft.



SMALL FIBREGLAS target rests in the reel section of the Bee-Jay tow reel system (top). Clamshell doors open in forward section (below) to suck in air which activates turbine wheel that, in turn, operates reel utilizing 25,000 ft. of 3/64 in. steel cable holding target. Size of clamshell door opening determines reeling velocity. Canted fins cause target to spin, increasing radar reflectivity. System was developed by USAF and Northrop.

THE ERA OF THE ELAND IS BEGINNING ...

How many development hours is 'know-how' worth?

Why is the Eland ahead of its time? The answer lies years back—in the steady accumulation of engineering skill and experience that forms the 'Napier tradition'. This 'know-how' made us decide on the single-spool as opposed to the twin-spool—and at the same time showed us the way to find the compressor we needed.

In 1947 it was clear to us that only by basic research on stage matching could we find that compressor—one which would make possible a single-spool turbo-prop with the simplicity, the economy, the power and flexibility of the Eland.

So we built at Liverpool the best-equipped gas-turbine research station in Europe. The original work we have carried out in that station has given us a knowledge of compressor problems—and their solutions—equalled by few other aircraft engine firms.

After thousands of hours of cascade work we determined by 1952 the right type of blade to use, its general aerofoil characteristics and the basic geometry of the compressor itself. Even at this stage, a very large number of possible compressors could have been built.

We now had to make a vital decision. Which prototypes—out of this very large possible number—should we build? Theory wasn't much help here.

We had to depend on 'know-how' and the engineering sixth sense it gives. The right answer could save us thousands of hours of work—the wrong answer could put us back years.

It was decided that we should start by building four compressors. When we had built the third we knew we had what we wanted! By now we have been able to put in three years steady development work on the same blade/compressor combination.

With a type test at 3,060 e.h.p. successfully completed we can say now that the Eland's design is basically sound, basically right, and will not have to be fundamentally altered in the years ahead. Of how many turbo-props can that be said? The Era of the Eland is beginning with an engine of *proved* safety and flexibility.

HOW ARE YOU GOING TO USE THE ELAND TO YOUR ADVANTAGE?

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Partners in Progress with The ENGLISH ELECTRIC Company Ltd

Representatives

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P J WAITE Marcoal Aviation Dept., 970, McEachran Avenue Montreal 8, Quebec. Tel: Victoria 3627

USAF Contracts

Following is a list of unclassified contracts for $25,000 and over as released by Air Force Contracting Offices

WARNER ROBINS AIR MATERIEL AREA, Robins Air Force Base, Ga

Radio Corp of America, Front St., Camden N J modification kits for retrofit of various fire control systems (PR 431244) $25886

Stratton Equipment Co., 2030 East 105th St. Cleveland 6 Ohio mobile floor cranes 2 ton capacity type 2 class 2 IAW spec Mil C 4551A 183 ea (IFB 435) $68781

Sperry Gyroscope Co Great Neck N Y modification kits for retrofit of A 1A FNC systems (PR 681206) $325687

DAYTON AIR FORCE DEPOT, Gentile Air Force Station Dayton 10 Ohio

The Sperry Rand Corporation, acting through Sperry Gyroscope Company Division Great Neck N Y repair of test equipment 200 ea (PR GE-549480 $40880

General Electric Company (Aircraft Gas Turbine Division) Evendale Ohio integrated elec cont calibrator 5 ea (call 56 8) $76020

The Magnavox Company, 2101 Bueter Road Fort Wayne Ind receiver subassembly used as cull assy Magnavox P/N 367872 2, 2540 ea, (RFP 33 604 56 3480) $54 992

Magnaflux Corp., 7300 W Lawrence Ave., Chicago 31, Ill. inspection equipment magnetic particle port 104 ea, spare parts handbook data engrg data (RFP 33-604-56-3080) $169030

Varian Associates 611 Hansen Way Palo Alto Calif. electron tubes 1000 ea (PR 838597) $63500

Tektronix Inc., P O Box 831 Portland 7 Oreg oscilloscope 5 screen tektronix type 545 with type 53/54K plug

Continental Electric Company 325 Ferry St, Newark 5 N J armature dynamotor slot wnd type appl RT-178/ARC-27 continental elec P/N B41584 WS11054 1000 ea, cap electrical, bakelite f/O RT-178/ARC 27 Continental Elec P/N 32311-1 2500 ea (RFP 33 604 56-23781 $46975

General Electronics Inc 101 Hazel St Paterson N J tube electron Jan type no 1641 transmitting rect vacuum IAW MIL E-1Cdtd 3 Oct 55 and suppl 1C dtd 23 Dec 55 Mil-E-1/132 dtd 19 Mar 53

Sperry Gyroscope Company Div of Sperry Rand Corp Great Neck N Y., crystal unit 2900 ea (call 56-2) $34680

Gera Corp., Chatham-Electronics Div 630 W Mt Pleasant Ave Livingston N J contact assembly (vacuum switch) relay Chatham 1523 1500 ea, (RFP 33 604 56-22531 $66250

SHELBY AIR FORCE DEPOT, Wilkins Air Force Station Shelby Ohio

Precision Aviation Products Inc 27 Mechanic St Buffalo 2 N Y stand aircraft engine type MF-5 designed for R1300 engine IAW USAF DWG 55D5000 104 ea $29441 stand aircraft engine type MF-6 designed for R11820 engines IAW USAF DWG 55D5060 132 ea $21095 less 1 percent reduction on award of all items total $00525 (IFB 33 602 56-144)

The Alvey-Ferguson Co., North & Dinsey Streets Cincinnati 9 Ohio services and material to install mechanized material handlings system in warehouse at Shelby AF Depot Shelby Ohio (PR WL 16G 56 3541 $186980

HOLLOMAN AIR FORCE BASE N M

University of New Mexico Albuquerque N Mex. mathematical studies (AF 29 (600)-925 job $37800

AIR FORCE MISSILE TEST CENTER Patrick Air Force Base (ARDC), Fla

Technical Engineering Co 1771 North 4th Street Philadelphia 33 Pa fabrication installation and testing of FLAC II digital computer (P R No FP-1 (56)-410) job, $213121

Interstate Engineering Corp Interstate Engineering Corp Interstate Electronics Division 675 S East Street, Anaheim Calif, engineering services to evaluation ELSSE for range safety (P R No FP-1 (56) 382), job $45542

Vitro Laboratories, Division of Vitro Corporation of America 200 Pleasant Valley Way West Orange N J design development and fabrication of timing terminal units model 0864 (P R Nos FP-1 (56)-350 FP-1 (56) 400) job $110,651

Flight Research Incorporated, Post Office Box 1-F Richmond Va camera data recording 35mm and accessories, (P R No. FP-1 (56) 250) job $26805

Ralph M Parsons Company 135 West Dayton Street Pasadena Calif one hundred ten (110) data insertion converters and seven hundred eighty one (781) plug-in units, (P R Nos FP 1 (56)-282 FP-1 (56) 432) job $137627

Milgo Electronic Corporation 7601 N W, 37th Ave Miami 47 Fla additional radar data transmission equipment (P R No FP-1 (56)-326) job $70132

Canoga Corporation 6656 Sepulveda Blvd Van Nuys Calif consideration and payment of the schedule to contract no AF 08 (606)-786 (P R No FP-1 (56)-507) job $100000

Electro-Mechanical Research Inc. Ridgefield Conn. discriminator system engineering change and discriminator rack assembly TARE II (P R Nos FP-1 (56)-397 FP-1 (56)-403 FP-1 (56)-411) job $38870

General Dynamics Corporation, (Convair Division) San Diego Calif additional funds for AZUZA tracking system (P R No FP-1 (56) 270), job $1600000

Canoga Corp 5955 Sepulveda Blvd Van Nuys Calif revision in work statement covering instruction book manuscript and instruction books, (PR No. FP-1(56)-402), job $40000

John C Abbott P O Box 1536 Vero Beach Fla. services and materials for modification to Silver Beach Housing Bldgs. 430 thru 474. (IFR No 08-605-56 113), job $55310

OFFICE OF SCIENTIFIC RESEARCH, Air Research and Development Command, P O Box 1395 Baltimore Md

University of Maryland, College Park, Md continuation of research program in statistical mechanics and its expansion to include studies in chemical physics (AF18 (600) 1315), job $47735

University of Maryland, College Park, Md research continuation on Phenomena Surroundings High Speed Flight (AF18 (600) 991) job $40000

Washington University, St. Louis Mo research nuclear reaction studies (AF18 (600) 1171 job $46543

Regents of the University of California, Berkeley Calif research, sampled data control systems (AF18(600)-1521) job $25886

Litton Industries 336 North Foothill Rd Beverly Hills Calif research development and testing of an inhabited manipulator station in a high vacuum environment (AF18(600)-1485) job $172520

Lovelace Foundation for Medical Education and Research 4800 Gibson Blvd S E, Albuquerque N Mex. study of The Use of Automatic Gas Analysis to Determine Respiratory Efficiency (AF18(603)-80), job $.7372

Baylor University, Houston Tex research Investigation of the Effects and Mode of Action of the Psycho-chemicals on Human State of Consciousness (AF18-(603-79) job, $51075

ROME AIR FORCE DEPOT, Griffiss Air Force Base N Y

General Cable Corp Railroad St. Rome N Y this military establishment has placed the following contracts for the week ending this date cable telephone 51 pr WC 365 type II IAW MIL C 3458 182000 ft cable-telephone 20 pr WC-376 type II IAW MIL C 3458 290000 ft cable telephone 104 pr type WM 80/U IAW MIL-C 3458 9545 ft (RFP 30 635 56 4187Q) $216870

General Cable Corp Railroad St., Rome N Y cable telephone 300 good grs type WC 453 IAW spec MIL C 13017 (Sig C) application telephone (RFP 30 635-56-4127Q) 107000 ft $450256

Ringwood Chemical Corporation, Ringwood Ill fixer acid hardened single blended powder (RFP 30 635 56-4405Q), 5000 pkg $67500

CAB Accident Investigation Report

Puget Sound Crash Follows Buffeting

Northwest Airlines Flight 2, a B-377, N-90608, was ditched in Puget Sound 4.7 nautical miles southwest of Seattle-Tacoma Airport, April 2, 1956, at 0810,[1] approximately four minutes after takeoff. All occupants successfully evacuated the aircraft but four of the 32 passengers and one of the crew of six drowned. Two passengers incurred minor injuries during the ditching. The aircraft, although later recovered, was a total loss.

HISTORY OF THE FLIGHT

Flight 2 was scheduled daily between Seattle, Wash., and New York with intermediate stops at Portland, Ore., and Chicago. It departed Seattle-Tacoma Airport at 0806 on an IFR flight plan to Portland via Victor Airway 23 to cruise at 6,000 ft. There were 32 passengers and a crew of six consisting of Capt. Robert Reece Heard, First Officer Gene Paul Johnson, Flight Engineer Cecil Vernon Thomson, Flight Service Attendant David V. Razer, Senior Stewardess Elinor A. Whitacre, and Junior Stewardess Dorothy L. Cutting.

Takeoff was made on runway 20 and the flight climbed to an altitude of 1,000 to 1,200 ft. At this time power was reduced and the wing flaps, which had been set at the normal 25-degree takeoff position, were retracted at an airspeed of 145 knots. Immediately, the crew became aware of severe buffeting and a strong tendency of the aircraft to roll to the left. Because the buffeting began almost immediately after the flaps were retracted, the captain believed that it was due to a split flap condition, i.e., the wing flaps on one side of the aircraft being retracted while the flaps on the other side remained partially or fully down. Power was reduced momentarily in an attempt to alleviate the buffeting, but this was not effective, and maximum continuous power was again restored.

After being cleared in the Seattle tower for return, the captain decided not to turn the aircraft because of control difficulty and advised that he would proceed to McChord Air Force Base at Tacoma. Thereafter, the captain testified the throttle became loose, and the aircraft continued to lose altitude. The captain elected to ditch and did so at approximately 0810.

Touchdown was on smooth water at an airspeed of approximately 120 knots and there was an abrupt deceleration. Passengers and crew members, except the captain and first officer, left the aircraft through the main cabin door and emergency exits. The captain and first officer, after a passenger count, left the aircraft through cockpit windows and swam to the left and right wings, respectively. The aircraft sank in approximately 15 minutes, and by that time all persons on the wings had been supplied with buoyant cushions from the cabin seats. Those who survived were rescued by surface craft from the 42-degree F water within 30 to 35 minutes from the time of ditching.

INVESTIGATION

Seattle-Tacoma Airport 0730 weather was: Measured ceiling 1,200 ft., visibility 10 mi., altimeter setting 30.12, wind east northeast 7 knots.

With the load properly distributed, the gross weight of the aircraft at takeoff was 118,576 lb, the maximum authorized takeoff weight is 124,000 lb.

The ditching site was 4.7 nautical miles from the end of runway 20 and on a magnetic heading of 198 degrees. The water at this point is approximately 72 fathoms (432 feet) deep.

Personnel of the Board, Northwest Airlines and maritime agencies participated in recovery operations. Underwater television was used after the wreckage was located and before raising commenced. Owing to the depth of the water and inability to immobilize the surface suspension, the results of using television were not satisfactory. The wreckage was then moved to water 40 ft. deep where divers, one aeronautically experienced, made an initial inspection.

This inspection revealed that the No. 1 engine had been torn off, that the wing flaps of both wings were fully retracted and that the cowl flaps of the three remaining engines were fully open. The aircraft was then raised and placed on a barge for detailed examination. Examination confirmed that the wing flaps of both wings were fully retracted and that the cowl flaps of the three remaining engines were fully open.

The cowl flaps were open approximately eight inches, as measured between the No. 7 cowl flap shingle and the recessed cowling. Full cowl flap opening is eight inches, plus or minus one-fourth inch. Cowl flap actuators of all four engines were one-eighth inch from contacting the full-open limit switches. The cowl flap jack screws were extended approximately 6⅞ inches, full-open jack screw extension is approximately seven inches. Functional bench testing of the cowl flap actuators, relays and indicators revealed normal operation.

Week's Search

Search for the missing No. 1 engine, with the use of sonar[2] and other methods, continued for more than a week without success. A metallurgical examination of the No. 1 engine mount revealed no evidence of fatigue failure. Marks on the shank of a bolt in an upper outboard member indicate a load in an upward inboard direction. This is unlike previous failures in flight. Examination of the Nos. 2, 3, and 4 engines, which remained intact on the aircraft, gave no evidence of malfunctioning prior to impact. This was further substantiated by testimony of the three crew members that normal power from all four engines was available at all times until contact with the water.

The No. 1 engine top accessory cowling section was not found. This part is believed to have been forced off by hydraulic action during the ditching. Confirmation of this belief is indicated by the buckling rearward of the No. 1 firewall and also by the lack of wing surface damage in the No. 1 nacelle area. No crew member or passenger recalls observing any parts leaving the aircraft prior to impact.

Examination of the aircraft disclosed no failure or irregularities in any of the aircraft controls, control indicators or limit switches prior to the ditching. This was substantiated by testimony of the flight crew that the aircraft was ditched under full control.

The captain stated that loss of control was believed imminent because of excessive buffeting, inability to maintain altitude and a tendency of the aircraft to roll to the left which required nearly full use of aileron to correct. His statement reads (in part):

"In electing to ditch I predicated my decision on the probability of a split flap condition and a firm conviction that the aircraft was not going to stay in a controlled condition much longer." At this time, Flight Engineer Thomson asked Captain Heard if he should go to the cabin and visually check the wing flap positions. The captain advised him to remain at his station because of the impending ditching.

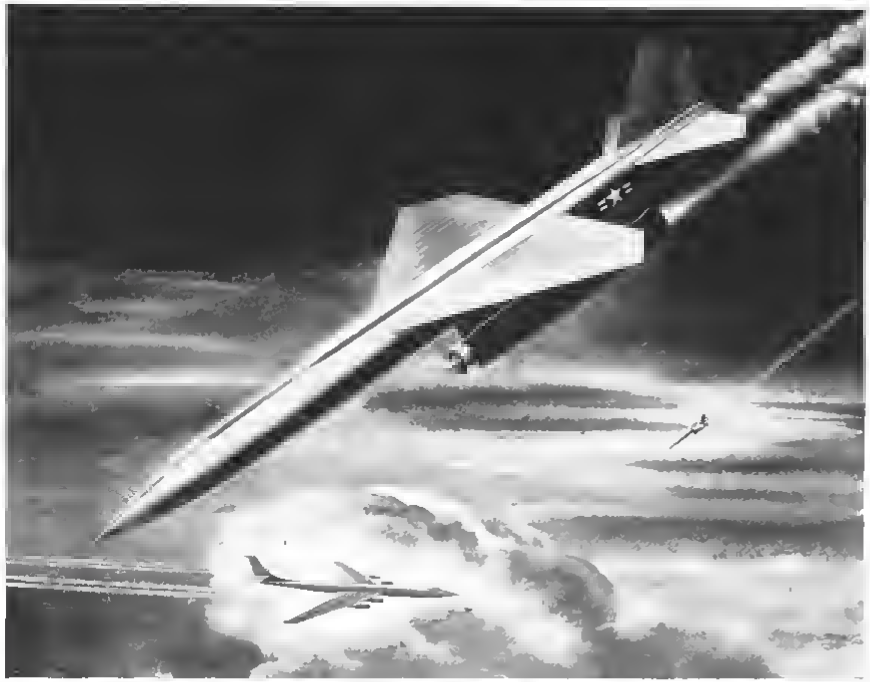
Detection System

Boeing 377 aircraft operated by Northwest Airlines are equipped with a wing flap unbalance detection system which gives a signal in the cockpit of five degrees' flap differential between the left and right flaps. The wing flap position indicator in the cockpit is operated from the right wing flap. According to the crew, the normal and emergency wing flap drive systems and the wing flap unbalance detection system were checked before takeoff and all functioned normally. Also the crew stated that when the flaps were retracted from the 25-degree takeoff position the wing flap indicator showed full up or retracted position. There is also a propeller unbalance system that was checked before takeoff and all crew members testified there was no signal of propeller unbalance during the flight.

Crew members testified that all ground checks were accomplished. After the runup, which was made near the start of takeoff,

[1] All times referred to herein are Pacific standard and are based on the 24-hour clock.

[2] A device used in underwater search operations.



SAFETY

the departure clearance was heard by all crew members and then the flight engineer made his challenge and own response to the item "Cowl flaps—Set for takeoff." He then called to the captain "Set for takeoff according to the captain's testimony

It is the flight engineer's responsibility to close the full-open engine cowl flaps prior to takeoff The flight engineer stated he was not certain the cowl flaps had been closed at that time Flight crew members testified that a visual check of cowl flap position was not made prior to the ditching or after the buffeting commenced

Flight Engineer Qualified

The flight engineer was qualified on three different types of aircraft DC-6 L-1049 and B-377 His B-377 time in the 90 days preceding the accident was one hour and 40 minutes during a requalification check on March 16, 1956 He testified that most of his flight time had been on L-1049's and DC-6's the preceding year His flying hours as of April 1 1956 totaled 1,384 236 of which were in B-377 equipment

During the hearing the flight engineer was asked if he remembered actuating the cowl flap switches during the before takeoff check His answer was, "I can't actually honestly tell you that I really did or did not The cockpit cowl flap controls on the B-377's and L-1049's move in opposite directions for the closing of cowl flaps and at the hearing the flight engineer testified that it was possible he had moved these controls in the wrong direction prior to takeoff thus leaving the flaps in their already open position

Special Check

Following the accident a special check flight was made in another Northwest Airlines B-377 with the crew of Flight 2 operating the aircraft and the Superintendent of Flying Western Region Northwest Airlines acting as observer In addition to the check flight simulation of the conditions experienced on Flight 2 was also conducted Four takeoffs were made with the engine cowl flaps in various positions Control was normal until the wing flaps were retracted

The final takeoff was with full open cowl flaps on all four engines There was no distinguishable effect on control or buffeting until the wing flaps were retracted As the flaps retracted buffeting and control difficulty commenced and reached a degree that in the opinion of the crew was very similar to that experienced by them during the flight of April 2

In addition test flights made by the Boeing Aircraft Company in a similar aircraft using open engine cowl flap position on takeoff produced the same results when wing flaps were retracted In all of these flights buffeting ceased and aircraft control became normal when the engine cowl flaps were moved to the normal flight position

Following the takeoff Flight 2 was observed by the Seattle-Tacoma Airport tower controllers directly and on the ASR (Airport Surveillance Radar) scope The visual controllers testified there was no change in heading of the aircraft from runway 20 until it disappeared below the tree line Other ground witnesses near the scene observed the descent and ditching and with one exception stated that they did not

SAFETY

observe any part separate from the aircraft prior to water contact.

One witness who stated he saw a part come from the aircraft while it was in the air, was stationed approximately four statute miles to the east of the line of flight. This witness was subsequently accompanied by Board investigators to his point of observation and through an actual flight path reenactment it was determined that the subject aircraft could not have been seen from that location. This witness described the part as being similar to the size of a door and coming from the area of the lower forward baggage compartment.

Examination of the wreckage accounted for all such parts as having been in place when the ditching occurred. A wide search of the ground was made and no parts were found. In addition a door check was made before takeoff and the crew stated no door warning light came on during the flight.

Experienced in Airplane

All of the flight crew members had several years and many hours of experience in B-377 aircraft. They stated that buffeting from excessively positioned cowl flaps had never been experienced by any of them either in check or regular flights. However, their testimony indicated that all three crew members were familiar with the pages of the flight operations manual covering the subject of buffeting. The manual notes open cowl flaps as a cause of buffeting in cruise configuration and prescribes the extension of wing flaps as a corrective measure.

The NWA Manual (Flight Operations—Boeing 377 Aircraft) is issued individually to all flight crew members. It is their responsibility to be entirely familiar with the contents and keep the manuals current as additions are issued to them.

There have been other previous instances where other operators of B-377 aircraft have experienced flight difficulties because of cowl flaps being inadvertently opened. Details of these instances were disseminated (in 1952) by request of the CAB to all operators of B-377's through the medium of CAA alert bulletins, notices from the manufacturer, and the Air Transport Association. Investigation revealed that this information was received by NWA and distributed to their flight personnel.

Study Prepared

At the Board's request, the airframe manufacturer prepared a study of the effect of full open cowl flaps on the performance and controllability of the B-377 aircraft. This study indicates that the use of full-open cowl flaps during takeoff with the normal 25 degrees of wing flaps does not result in abnormal takeoff characteristics.

Further, the study indicates that when wing flaps are retracted and cowl flaps are fully open, no noticeable buffeting is experienced until the wing flaps are within about 10 degrees of the fully retracted position. Vibration and buffeting then builds up rapidly and becomes severe as wing flaps reach full up. This vibration is more regular than buffeting in a full stall but is not as violent. With the increase in turbulence over the wings associated with the buffeting, lateral stability is reduced and tends to give the impression that the airplane is being balanced on a pedestal. Lateral trim

U. S. Air Force Photo

Designed basically for night photographic work, the Martin RB-57 is employed by USAF TAC, powered by two Wright J-65 jet engines

WADC'S WEAPONS GUIDANCE LABORATORY GIVES ACCURACY TO AIR FORCE BOMBS, MISSILES AND AIRCRAFT

The Weapons Guidance Laboratory at the Air Research and Development Command's Wright Air Development Center performs applied research and development of all Air Force weapons guidance equipment.

Included under this broad category are airborne bombing systems and equipment, weapon defense systems, offensive fire control systems, missile guidance equipment, electronic jamming systems, chaff systems, navigation systems, manual navigation aids and special test equipment peculiar to the requirements of the weapons guidance systems or equipment. In addition, all components of the foregoing are the province of this laboratory. The facilities available for these studies include various gun ranges, temperature and altitude chambers and other specialized test and evaluation installations.

Weapons Guidance is one of the laboratories that form the Wright Air Development Center. WADC, in turn, is the largest Center under the Air Research and Development Command. At its location at Wright-Patterson Air Force Base, Ohio, upward of 10,000 military and civilian workers are engaged in research, development and testing of aircraft, guided missiles and all types of associated flight and ground equipment.

Engineer at Ford Instrument Company checking unit designed by the Company for the Air Force to be certain that its magnetic effects will not affect other instruments in the aircraft

SAFETY

requirements and more than likely be abnormal but not excessive.

Performance capabilities of the airplane in the cruise configuration with all cowl flaps wide open and operating all engines at maximum continuous power may be likened to that with one engine inoperative and the cowl flaps in the normal setting. In this regard, positive rates of climb in excess of 600 ft. minimum would be possible and turns in either direction could be made without undue difficulty.

The data further indicates that buffeting with flaps up, although considered severe, is not of immediate concern as a cause of structural damage. The most pronounced effect on control or stability is in a lateral direction and a moderate amount of aileron control for trim may be required, probably to the right even though all cowl flaps may be open the same amount.

ANALYSIS

All evidence indicates that the cowl flaps on all four engines were approximately full open during the entire period of the subject flight. Test flight results proved conclusively that in the above aircraft configuration buffeting occurs when the wing flaps are retracted. It is believed that the cowl flaps remained in the full open position during and after the before takeoff check for the following reasons. The NWA operations manuals direct that the flight engineer, after hearing the takeoff clearance in his own headset, shall then make his own challenge and response to the item 'Cowl flaps—SET FOR TAKEOFF.' To accomplish this requires that he actuate the four cowl flap switches forward either individually or by the gang bar and then monitor the movement of each cowl flap on its respective indicator in front of him on the engineer's pedestal and above the cowl flap switches. This monitoring ensures that the flap openings shall be the recommended amount, temperature rise and in no event more than three inches.

The Board can offer no explanation for the flight engineer's failure to set the cowl flaps properly in the takeoff position. During the investigation and public hearing the adequacy of Northwest's flight engineer training program was thoroughly explored. The training program was complete and complied with the applicable Civil Air Regulations in every respect. Furthermore, it was developed that Flight Engineer Thomsen had successfully completed the base program and the subsequent periodic checks.

In addition his total flying time and time in the equipment involved is impressive and is the Board believes further evidence of his general competency. Airline flight personnel are trained to be deliberate and to follow prescribed check procedures. Had Flight Engineer Thomsen acted in accordance with his training and previously demonstrated capabilities, his original omission would not have been made or if made, would have been detected before the captain committed the aircraft to ditching.

Flaps Not Extended

The CAA approved manual recommends that in a water landing 25 degrees of wing flaps should be used to decrease airspeed and rate of descent. The fact that the wing flaps were not extended in the subject landing supports the captain's statement that in his mind a split flap condition existed.

However, if his analysis of the difficulty had gone further, his knowledge of the B-377 would have made him aware that with the wing flap cockpit indicator showing full retraction and his thought of a failure of the flap unbalance system allowing an unsignaled extension of the left wing flap the tendency of the aircraft would have been to roll to the right and not to the left as in the actual occurrence. Regardless of the incorrect analysis of the difficulty, a visual check of the wing flaps would have eliminated this factor and pointed to a check of other possible causes.

The majority of causes of buffeting listed in the NWA flight manual could have been checked by actual observation or cockpit indication. Nos. 1 and 4 nacelles could have been observed from the cockpit. Had this been done the open cowl flap condition would certainly have been detected.

Although the evidence shows that Captain Heard and First Officer Johnson could have leaned forward and looked out their respective side windows and have seen the cowl flap settings, this did not occur as there since Flight Engineer Thomsen's challenge and response was in itself the customary assurance that the cowl flaps were set properly for takeoff.

In addition the captain was faced with a series of adverse conditions, such as low ceiling and unfavorable terrain and it was his belief and decision that ditching was the safest action since he was convinced that any attempt to continue flight would result in complete loss of control of the aircraft.

The Board realizes that all of these events were occurring within an extremely short period of time and that the apparent urgency of the situation required a rapid decision by the captain. Captain Heard did act promptly as the situation demanded but his incorrect analysis of the control difficulty led to an unfortunate decision.

The pressures of the situation and the limited time available to the captain to arrive at a decision no doubt had an important bearing on the action he initiated. However the Board believes that flight manual information on the conditions created by excessive cowl flap openings was sufficiently stressed to allow the captain and indeed the entire crew to evaluate the difficulty properly within the time available.

Seat Cushions Used

Passengers on the flight were entirely in agreement that the use of the seat cushions for flotation avoided a greater loss of life. Testimony of the passengers indicates a high standard of professional conduct on the part of all crew members in their care of the occupants after the ditching of the aircraft.

The subject flight being domestic, the carrying of flotation gear is not required by Civil Air Regulations. Although the use of seat cushions for buoyancy is not listed in the manual, the crew members were aware that they could be so used and their prompt action ensured that no passenger or crew member was in the water without

means of flotation after the aircraft sank.

Every consideration has been given to the probability of a contributory factor to the buffeting such as loose cowling, engine mounts open doors etc However, all phases of structure examination witness statements and ground search failed to support such a factor

FINDINGS

On the basis of all available evidence the Board finds that

1. The carrier, the aircraft, and the flight crew were currently certificated
2. The gross weight of the aircraft at takeoff was below its maximum takeoff weight and the load was properly distributed
3. Two minutes after takeoff an emergency was declared because of severe buffeting and control difficulty
4. The flight engineer did not close the cowl flaps to takeoff position
5. The cause of the buffeting and control difficulty was not determined by the flight crew and the captain made a decision to ditch the aircraft in Puget Sound
6. The ditching was made under favorable circumstances The aircraft sank in about 15 minutes and all survivors were rescued from the water shortly thereafter
7. The aircraft was recovered from over 400 ft of water and examination disclosed that all engine cowl flaps were approximately full open
8. The buffeting and control difficulty was caused by the improper setting of the engine cowl flaps
9. There was no failure or malfunction of the aircraft the powerplants or control systems prior to the ditching

PROBABLE CAUSE

The Board determines that the probable cause of the accident was the incorrect analysis of control difficulty which occurred on retraction of the wing flaps as a result of the flight engineer's failure to close the engine cowl flaps—the analysis having been made under conditions of great urgency and within an extremely short period of time available for decision

By The Civil Aeronautics Board

/s/ James R. Durfee
/s/ Joseph P. Adams
/s/ Chan Gurney
/s/ Harmar D. Denny
/s/ C. Joseph Mineth

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of the accident at approximately 0830 April 2, 1956. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and was held in Seattle, Washington, on May 21, 22, and 23, 1956.

AIR CARRIER

Northwest Airlines, Inc., is incorporated in the State of Minnesota and maintains its principal place of business at Minneapolis. The Company possesses a certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration which authorize the carriage of persons, property, and mail over the route described in this report.

FLIGHT PERSONNEL

Captain Robert Reese Heard, age 38, was employed by Northwest Airlines as a pilot on April 3, 1941. He held a valid airman certificate with an airline transport rating and type ratings for Douglas DC-4 and DC-6, Lockheed Constellation, and Boeing 377 aircraft. Captain Heard had, according to company records as of March 24, 1956, a total of 14,030 flying hours, of which 1,55[illegible] hours were acquired in Boeing 377 aircraft. His last proficiency check on B-377 equipment was on Jan. 2, 1956. His last first-class physical examination was successfully passed with no limitations on March 24, 1956. Time on B-377 equipment the last 90 days was 36 hours, with 95 hours on other equipment during the same period.

First Officer Gene Paul Johnson, age 32, was employed by Northwest Airlines as a pilot on July [illegible], 1949. He held a valid airman certificate with an airline transport rating and type ratings for Douglas DC-3 and airplane multiengine land. Mr. Johnson had, according to company records, a total of [illegible]29[illegible] flying hours, of which 1,143 hours were in B-377 aircraft. He received his last proficiency check on Feb. 20, 1956, and his last first-class physical examination was successfully passed with no limitations on Feb. 21, 1956. Time the last 90 days on B-377 aircraft was 109 hours, with 60 hours on other equipment.

Flight Engineer Carl Vernon Thomsen, age 32, was employed by Northwest Airlines on July 19, 1941, and was assigned as flight engineer in Dec. 1953. He held a valid flight engineer certificate and had, according to company records, a total of 1,384 flying hours, of which 236 hours were in B-377 aircraft. He successfully passed a second-class physical examination with no limitations on July 1, 1955. His last proficiency check on Boeing 377 aircraft was on March 16, 1956. His flight time for the 90 days preceding the date of accident was 168 hours, of which 140 hours were in B-377 aircraft.

Stewardess Elinor A. Whitacre was employed by Northwest Airlines on Feb. 20, 1951. Miss Whitacre completed the stewardess training course and her last emergency training procedures were taken in Feb. 1956.

Stewardess Dorothy L. Oetting was employed by Northwest Airlines on Sept. 22, 1951. Miss Oetting completed the stewardess training course and her last emergency training procedures were taken in Jan. 1956.

Flight Service Attendant David V. Razey, age 2[illegible], was employed by Northwest Airlines on Sept. 10, 1954. Special courses completed were the Initial Flight Service Attendant Training at the time of employment and his last Air Rescue Training Procedures taken in Feb. 1956.

THE AIRCRAFT

Boeing model 377, NC-4608, manufacturer's serial number 15954, was owned by Northwest Airlines, Inc., and was cur

rently certificated. It had accumulated a total airframe time of 18,489 hours with 1,324 hours since the last overhaul. The powerplants were four Pratt and Whitney model R4360-B6 engines equipped with Hamilton Standard propellers with model 24260-43 hubs and F2J1-113-SW blades. Total time on the four engines was between 11,491 hours and 12,524 hours and time since their overhaul was between 245 and 756 hours. Total time on the four propellers was between 685 and 10,264 hours.

Stock Transactions

Acquisition of 388,685 common shares of Braniff Airways stock by William A. Blakley, a director of the company, was reported by the Securities and Exchange Commission. The purchase raised Blakley's total Braniff holding to 517,995 shares. Charles E. Beard, an officer and director, acquired 8,100 common shares for a total holding of 21,600.

Other recent transactions include:

Acro Supply Mfg. Co. Inc. Acquisition of 300 common shares by Henry Brightman, director, for an indirect holding of 96,581; acquisition of 100 common shares by Sam J. Irvine, director, for a direct holding of 3,800.

Aeroquip Corp. Disposal of 100 common shares by Charles Hollerith, officer and director, leaving a holding of 16,030.

Air Associates Inc. Acquisition of 500 common shares by C. Kenneth Baxter, director, for a holding of 8,000.

Ayres Mfg. Corp. Acquisition of 800 common shares by C. Coburn Darling, director, for a direct holding of 3,100 and an indirect holding of 500.

Boeing Airplane Co. Disposal of 600 common shares by William M. Allen, officer and director, leaving a holding of 15,204; disposal of 400 common shares by James L. Prince, officer, leaving a holding of 1,750.

California Eastern Aviation. Acquisition of 100 capital shares by Ugo Carnicero, director, for a direct holding of 120,715 and an indirect holding of 41,833; acquisition of $31,000 of 6% convertible debentures by Edward A. Kerbs, director, his total holding.

Capital Airlines Inc. Disposal of 3,000 common shares by J. B. Franklin, officer, leaving a holding of 250; disposal of 1,000 common shares by Charles H. Murchison, officer and director, leaving a holding of 14,082.

Continental Air Lines Inc. Disposal of 700 common shares by Lawrence C. Ames, director, leaving a holding of 14,000.

Curtiss-Wright Corp. Acquisition of 500 common shares through exercise of option by Janice G. Byron, officer and director, for a holding of 1,000; disposal of 900 common shares by Frank H. Hankins Jr., officer, leaving a holding of 2,500; acquisition of 1,000 common shares through exercise of option by Marion E. Jordan Jr., officer, for a holding of 1,600.

Douglas Aircraft Co. Inc. Disposal of 500 capital shares by Arthur E. Raymond, officer and director, leaving a holding of 11,650.

Eastern Air Lines Inc. Acquisition of 700 common shares by Floyd L. Farley, officer, for a holding of 1,806; acquisition of 200 and disposal of 150 common shares by W. L. Morrisette Jr., officer, leaving a holding of 200.

Flying Tiger Line. Acquisition of 100 common shares by Oswald R. Burghardt, officer, for a holding of 500; disposal of 2,000 common shares by B. H. Rehrig, director, his total holding.

General Dynamics Corp. Acquisition of 10,000 common shares through exercise of

option by Earl D Johnson officer and director for a holding of 10 000 acquisition of 21 000 common shares by Frank Pace Jr officer and director for a holding of 30 000

Grumman Aircraft Engr Disposal of 900 common shares by E Clinton Towl officer and director leaving a holding of 8 000

Glenn L Martin Co Disposal of 3 000 common shares by J E Wharton Jr director leaving a holding of 16 500 disposal of 2 000 common shares by George T Willey officer leaving a holding of 1 250

National Airlines Inc Acquisition of 100 common shares by Richard A Fitzgerald officer for a holding of 100

North American Aviation Inc Acquisition of 300 capital shares through exercise of rights by J L Atwood officer and director, for a holding of 2 300 acquisition of 500 capital shares through exercise of rights by Herbert G Fales director for a holding of 2 500 acquisition of 417 capital shares through exercise of rights by James H Kindelberger director for a holding of 2 017 acquisition of 209 capital shares by Robert A Lovett director, for a holding of 22 200

Northrop Aircraft Inc Acquisition of 412 common shares through exercise of option by Charles C Cilley officer for a holding of 894 acquisition of 622 common shares through exercise of option by George Gorr officer for a holding of 622 acquisition of 700 common shares by Earle M Jorgensen director for a holding of 500 acquisition of 500 common shares by Robert R Millar officer for a holding of 500 acquisition of 966 common shares through exercise of option by Richard R Nolan officer for a holding of 966 acquisition of 1 452 common shares through exercise of option and disposal of 2 500 common shares by R J Page leaving a holding of 1 050

Pan American World Airways Inc Acquisition of 1 250 common shares through exercise of option by Erwin Balluder officer for a holding of 19 235 acquisition of 1 750 common shares through exercise of option by Henry J Friendly officer and director for a holding of 7 555 acquisition of 1 975 common shares through exercise of option by John C Leslie officer and director for a holding of 6 025 acquisition of 312 common shares through exercise of option by H Preston Morris officer for a holding of 2 501 acquisition of 875 common shares through exercise of option by John E Waadbridge officer for a holding of 3 300

Seaboard & Western Airlines Inc Disposal of 300 common shares by John H Rusenwald officer leaving a holding of 58 950

Slick Airways Inc Acquisition of 1 100 common shares by John R Alison director for a holding of 1 100

Solar Aircraft Co Acquisition of 820 common shares by Alexander Black officer and director making a holding of 4 455 acquisition of 175 common shares by D J Guth officer for a holding of 526 acquisition of 1 900 common shares by Leon T Noel officer and director for a holding of 4 400 acquisition of 2 116 common shares by Edmund T Price director for a holding of 32 581 acquisition of 100 common shares by Howard J Sleeper officer for a holding of 370 acquisition of 275 common shares by C W Salder officer for a holding of 550

Temco Aircraft Corp Disposal of 3 650 common shares by H L Howard officer and director leaving a holding of 21 160, disposal of 100 common shares by I Nevin Polley officer his total holding

United Air Lines Inc Disposal of 100 common shares by Curtis Barker officer and director leaving a holding of 2 451 disposal of 300 common shares by R E Johnson officer leaving a holding of 2 400

United Aircraft Corp Acquisition of 500 common shares by Joseph P Ripley director of 3 500 acquisition of 800 common shares by Aaron S Sopher director for a holding of 8 225 acquisition of 11 preferred shares by Carroll L Gould, officer for a holding of 11; acquisition of 263 preferred shares through exercise of rights by William R Robbins officer and director for a holding of 263 acquisition of 141 preferred shares by Bernard L Whelan officer, for an indirect holding of 141

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

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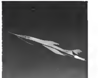

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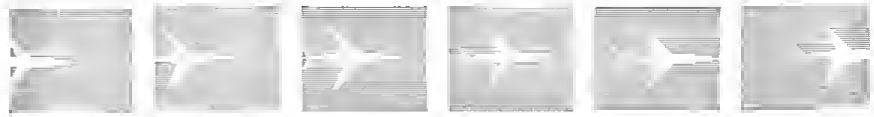

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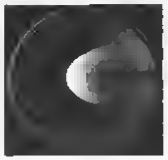

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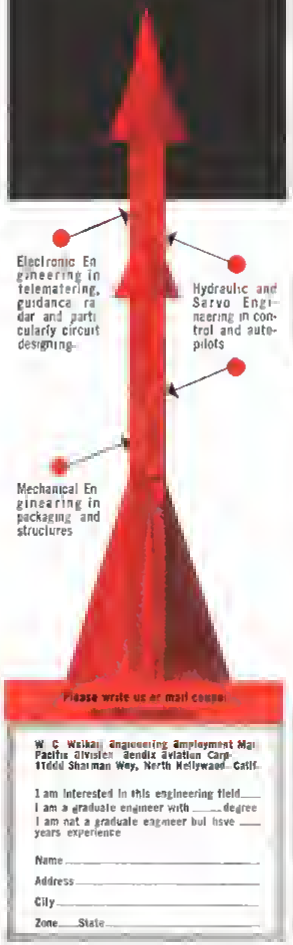

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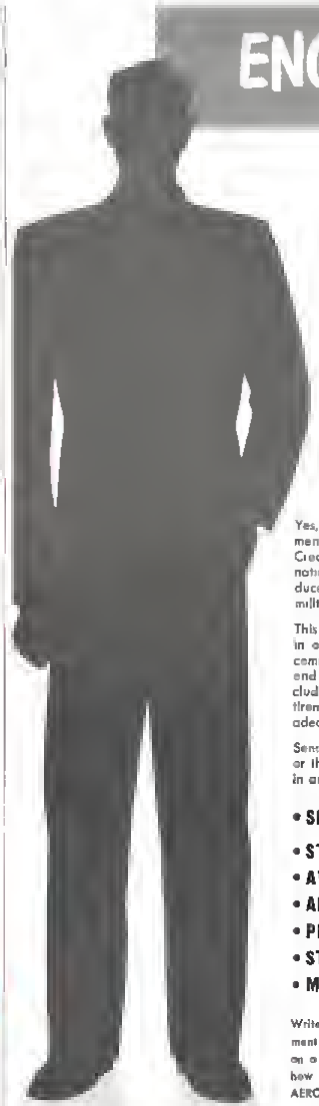

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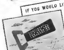

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AVIATION WEEK—DECEMBER 3, 1956

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ADVERTISERS INDEX

LETTERS

Britain's Air Defense

I thank you for your trenchant criticism of British aeronautics "What's Wrong With British Aviation?" (AW Oct. 29) Your leading interest should have read "What's Wrong With Britain's Air Defense."

The British Government rightly believes that attack is the best form of defense. Their force, the British bomber force—in relation to the size of the U. K.—with Valiants, Vulcans and Canberras is incomparable. Just around the corner is the Handley Page Victor—the world's "hardest to hit, hardest hitting bomber."

In the field of civil aviation, British turbojet, turboprop and piston-engined aircraft sales in the United States and throughout the world disprove complacency or indeed lack of competition within the industry.

You admit that British engine development is unsurpassed in the U. S. or elsewhere. Without British engine development the U. S. fighter force would consist of superb ground-borne airframes.

For these reasons the letter "Brotherhood of Bodge" (AW Oct. 29, p. 102) is 90% bosh.

Your criticism of British Air Defense, the lack of a weapons system, the bureaucratic bungling by the Ministry of Supply and lack of a high speed research programme (occasioned through the shortcomings of a faint-hearted Socialist Government some time ago) are appreciated by informed aviation people. Your comments will help the industry to drive some sense into the Government's Treasury Department and some air into the water-logged Supply Ministry.

You point out that the Western Alliance needs a strong Royal Air Force, but even the F-100 Super Sabre or the F-102A will be hard pressed to stop a modest 600 mph. Russian bomber—utilizing the element of surprise—from reaching British cities. Britain is far too close to the Soviet Union. Fighters or missiles or combinations of both with speeds of Mach 3 might be the answer.

Meanwhile our strength for peace lies in attack or reprisal. British bombers are presently among the world's best, while the equipment "around the corner" should outfly any Soviet defense.

Meanwhile, I think you for your sincere interest in British aviation.

K. S. H. Clarke
Surrey, England

Shortage Facts

Mr. Wheeler's letter (AW Oct. 15, p. 146) implies that the average aeronautical engineer receives $10,000 salary, works for a company that encourages him to present technical papers, and finds himself in a situation where getting an advanced degree pays off. But according to previous writers in this column, only 3% ever double the present starting salary, only a few of those doing original work can get permission from their company to publish it, and the average engineer with a Ph.D. makes no more money than the average one with a bachelor's degree.

Since this doesn't seem to be any technical society, government agency or philanthropic foundation both interested and able to poll the profession accurately or otherwise ascertain the facts, there seems to be a need for publishing the seriousness of this deficiency of factual information possible in your editorial page. The engineering shortage like any problem gets nowhere without facts. If these facts turn out to be pessimistic, access to them should help industry improve the situation. If they turn out to be optimistic, as Mr. Wheeler believes, a more widespread appreciation of them might reduce the present migration of graduate engineers to other fields. In either case, the results would be beneficial to our national security.

W. R.
Stratford, Conn.

There's a Difference

I am an "Aviation Gems Widow." Until my husband puts down the latest issue of your magazine. Often he reads some new aviation item to me, and normally I assume a knowing look, listen and nod tolerantly.

However, when he read me an item on the assembly of the Westinghouse Parabaloon (AW Oct. 22, p. 94), I finally had something to say. Gores are not used to make pleated skirts; they are used to make flared ones. As any amateur seamstress knows, there is a difference.

Jean Sidoroff
Flushing, N. Y.

(Avionics expert Klass, a bachelor, has lots to learn about women's skirts.—Ed.)

For More on Models

It came as a pleasant surprise to see that the 1956 Wakefield model competition was reported in Aviation Week (Oct. 1, p. 55). I have long felt that the aircraft industry in the United States was neglecting model aviation as a means of developing technical talent as well as from a public relations standpoint. Your article points this out in a very impressive manner. There is no excuse for the fliers representing this country to have to rely upon proficiency in order to compete in a world championship event.

Our need look only as far as the Russian team's performance in the 1956 competition to see the obvious benefits of securing the cooperation of interested governmental or industrial agencies. If such cooperation is needed to enable the Russian teams to compete in Europe it is totally necessary to enable American teams to compete on the same terms.

I sincerely hope Aviation Week will continue to report such important events in model aviation and I hope that the indifference shown by the American aircraft industry toward model flying in this country evolves into active support in the very near future.

W. Dunwoody
Grumman Aircraft Engineering Corp.
Bethpage, N. Y.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters but names of writers will be withheld on request.

Engine Cutting

A lot of hangar conversation and other comments should emanate from the pilot readers of Captain Robson's Cockpit Viewpoint on close to the ground engine cutting as an unadulterated flight training practice.

The question of course, is "Just how unadulterated should this stuff get to make the training effective and the pilot safer for the real thing?" I think it can be accomplished without needless exposure of say 1 million dollar piece of equipment plus 1 more or less reliable crew from the standpoint of accumulated experience.

Consider some other phases of training for the real thing. Even a check pilot doesn't set an airplane on fire so that a crew can cope with the real thing in flight. A crew doesn't usually ditch a land airplane in the ocean to cope with the real thing, nor does one practice gear up landings in case some day one might have to make a belly landing in an emergency. One doesn't practice seeing how close he can come to another plane in flight to determine if a collision could be avoided in the last few seconds.

Training incident reports frequently indicate that the accident is the result of a foul up by the check or instructor pilot rather than failure of the checkee to cope with the problem. As an extreme example I recall the case of the line check pilot who locked the flight controls in flight to observe how the crew would react. The passengers got more than they paid for.

A failure of one engine on a four engine aircraft should not be too much of a problem, but if it is required that it be accomplished consistently close to the ground it can become one. Keep crying "wolf" too often and one is apt to find a wolf of one's own creation. For that occasion there should be a preplanned out—in other words let's not cut it too close. Let's make a maximum use of drills in a position where the check pilot can cover up the checkee's mistakes plus one or two of his own. If this is done, I think there will be a few more people around to cope with the real problem if it ever arises. I am confident that the good judgment of the pilots who are so trained plus the accumulated effect of numerous drills from the safer position will produce the proper result if the real wolf ever comes.

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